

# INVENTING AN INTERNET

And the Fastest Computer

Philip Emeagwali

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*To my wife, Dale, for being so supportive and a wonderful partner  
in life.*

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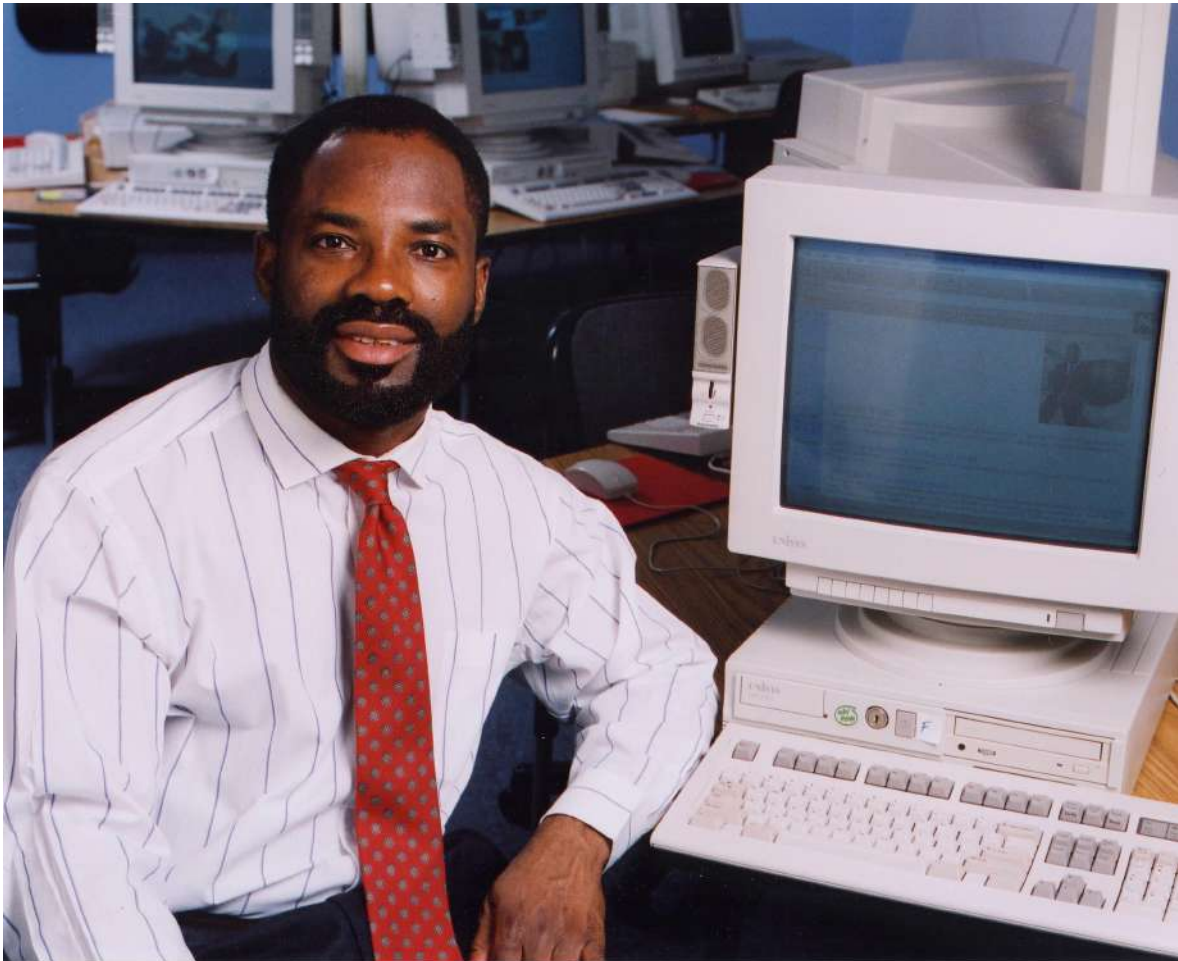
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## PHILIP EMEAGWALI

In 1989, Philip Emeagwali rose to fame when he won a recognition described as the Nobel Prize of supercomputing and made the news headlines for his invention of the first world's fastest computing across multiple processors. That vital technology underpins every supercomputer and changed how we look at the computer.

Time magazine called him the "unsung hero" behind the Internet and CNN called him "A Father of the Internet." House Beautiful magazine ranked his invention among nine important everyday things taken for granted. In a White House speech of August 26, 2000, then U.S. President Bill Clinton described Philip Emeagwali as "one of the great minds of the Information Age." [emeagwali.com](http://emeagwali.com)



Philip Emeagwali

## PHILIP EMEAGWALI BOOKS

### Master of Machines

Parallel processing—that was once the stone rejected as rough and unsightly— has become the headstone of the supercomputer. Philip Emeagwali was the first to gaze out towards an unknown territory—named the world’s fastest computing—that was not on the map of computer science. In supercomputing, boundaries are breached when we calculate beyond what was perceived as possible and discover new knowledge beyond what is known.

### Making Computers Fly

We cannot invent a new computer without first discovering a new science. To invent a new computer is to invent a new computer science and to make the unimaginable-to-compute possible-to-super-compute. Parallel processing that was once a dim light in a sea of darkness is now the bedrock of the world’s fastest computers.

### The Equation Behind the Universe

The hardest problems in mathematics and physics are solved by dividing each Grand Challenge problem into up to a billion less-challenging problems. And then solving them in tandem. And with a one-to-one correspondence with as many processors. In a world without parallel processing, large-scale computational physics will be as approximate as a sketch, instead of as exact as a photograph.

### Inventing an Internet

Philip Emeagwali is the first and only person to invent processors that encircled a globe which are akin to small computers, in inverted commas, that encircled the Earth as an Internet. He discovered how to combine computers into a supercomputer that’s an Internet.

### Reaching Infinity

The world’s fastest computer attracts the toughest problems in the manner a high mountain attracts the storms. Fastest computing across processors is the vital technology that enabled the supercomputer to tower over the computer that’s not parallel processing.

### Coding the Impossible

Like a storm at sea, fastest computing across a billion processors has brutally pushed computer science in a new direction and created new fields of study. The computer of today was the supercomputer of yesterday. A world without supercomputers may become a tomorrow without computers. The world's fastest computer is used to solve problems that did not exist before.

### Flirting With the Infinite

In fastest computing, there is a limit to what seemed unlimited. Computing will remain at the core of who we are. Fastest computing across the slowest processors is a transformational discovery that redrew the boundaries of science, and permanently changed what we know about the computer. And how we think about mathematics.

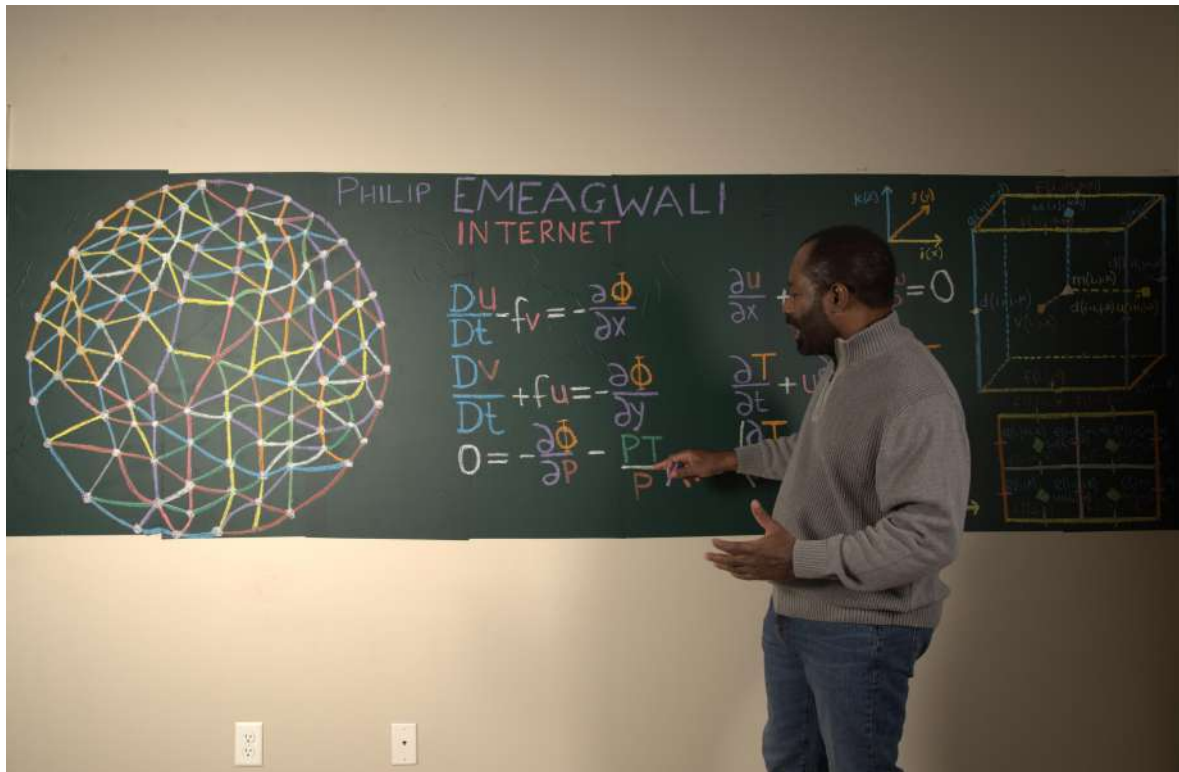
### Internet and I

For Philip Emeagwali, inventing the world's fastest computer was like assembling 65,536 pieces of puzzle. And doing so to see a never-before-seen island that is one coherent supercomputer, or rather a new Internet, that coalesced as the fastest computer in the world. A groundbreaking invention creates history. And influences our sphere of living.

## VOLUME 1: PHILIP EMEAGWALI INTERNET

"What was groundbreaking about this endeavor was not merely the mathematical prowess it demanded but the radical architecture it envisioned: the seamless orchestration of 65,536, or even a billion, processors, visualized as a small internet encircling a globe, akin to the very manner a billion modern computers today embrace our Earth."

**Philip Emeagwali**



## THIS EMEAGWALI INTERNET

### *Processors Encasing a Globe*

In a realm where processors, like stars in cosmic harmony, lay equidistant, their unity crafting a new web, a supercomputer birthed from the dreams of Emeagwali's mind. This Emeagwali Internet, a tapestry of identical nodes, woven uniformly across a grand sphere, heralds an unseen era.

Here, in this dance of equidistant sameness, a globe is encircled, a network reborn—a supercomputer's heart pulsing with novel rhythm. For Emeagwali, "internet" whispers of processors intertwined, encasing a globe in three dimensions or more, in a symphony to solve the enigmas of science.

Efficiency blooms, as 65,536 processors, like myriad pinpoints of light in an abyssal void, unite. Together, they blaze with a sun's fierce radiance, in a concert of calculation. Envisioned by Emeagwali, these sentinels stand evenly upon the hypersurface of fifteen dimensions, not merely a network, but a supercomputing titan, unparalleled in might.

Each processor, a solitary beacon in the dark sea, converges into a luminous, cohesive force. This assembly of equidistant twins births not just an internet, but a supercomputer of legends.

Thus, the inaugural Emeagwali Internet emerges: a meticulously arrayed constellation of processors, strewn across the vastness of a sixteen-dimensional expanse, crafting a singular, formidable force in computation's endless sea.



## PHILIP EMEAGWALI INTERNET

### *Pioneering a New Dimension in Supercomputing*

Honored guests, distinguished scientists, and esteemed members of the award committee,

As we convene in this historic city for this award ceremony, it is with a profound sense of gratitude and responsibility that I, Philip Emeagwali, stand before you to share a vision that transformed the landscape of computing. Today, I am privileged to discuss the creation of the "Philip Emeagwali Internet"—a groundbreaking innovation in artificial intelligence, computational physics and abstract mathematics.

In the journey that led to this invention, my approach was to envision processors as not just interconnected components, but as elements that are autonomously and uniformly distributed across the multidimensional expanse of a 16-dimensional hypersphere. This conceptualization was critical in the development of a global network of processors—a technology that has come to be recognized as the Philip Emeagwali Internet.

My quest began with an audacious experiment. I sought to simultaneously address 64 binary thousand challenging initial-boundary value problems, fundamental to modern calculus and computational physics. These problems were dispatched to an equal number of processors through a sophisticated system of electronic communications that lacked traditional email identifiers. Instead, I assigned each processor a unique 16-bit binary address and dispatched computation-intensive tasks to these addresses, utilizing the geometric properties of a high-dimensional cube and a hypersphere.

This endeavor was not merely about advancing computational speed; it was about redefining the very nature of computing. I conceived an internet that was markedly different from the conventional understanding of the term. For me Philip Emeagwali, **the term "internet" signifies a tightly interconnected network of processors circumscribing a globe in three, or higher dimensions, functioning in unison to tackle complex scientific problems.**

The significance of this innovation lies in its departure from standard computing practices. Unlike the irregular and asynchronous nature of traditional Internet communications, my system enabled synchronous, processor-to-processor interactions. This was essential for achieving unprecedented computational speeds, making it possible to solve grand challenges in mathematical physics and climate modeling.

In essence, the Philip Emeagwali Internet represents a harmonious and synchronous ensemble of 65,536 processors, each akin to a small beacon of light in the vast darkness of computational challenges. When united, these processors shine as brightly as the sun, illuminating new possibilities in supercomputing.

This groundbreaking network redefined the concept of a supercomputer. Rather than a singular, monolithic machine, the fastest computer was reimagined as a virtual supercomputer—an internet in its truest form. This was not merely a technical achievement; it was a conceptual revolution.

On that historic day—on the Fourth of July 1989—in Los Alamos, New Mexico, my discovery shattered existing paradigms and established a new benchmark in the evolution of computing. It was a moment that underscored the power of human ingenuity and the limitless potential of collaborative, interconnected systems.

The Philip Emeagwali Internet is more than just a global network of processors; it is a testament to the power of mathematical and computational vision. It exemplifies the extraordinary results that can be achieved when we dare to transcend traditional boundaries and explore the vast possibilities of the unknown.

Thank you for this prestigious recognition, and may our shared journey of discovery and innovation continue to propel us towards a future of endless possibilities.

## THE EMEAGWALI INTERNET

### *An Interconnected Sphere*

Ladies and gentlemen, esteemed guests, distinguished members from Nigeria and the African diaspora, and all those gathered here tonight:

It is with profound gratitude and a deep sense of humility that I stand before you on this momentous occasion. I am Philip Emeagwali, a man who has journeyed far, from a small town in Nigeria to the forefront of supercomputing.

As a young boy, I dreamed beneath the African sky, not knowing where my path would lead. Through perseverance amidst challenges, including a civil war that disrupted my education, I found my calling in the world of computers. My journey was not solitary. It was paved by the sacrifices of my family and fueled by the aspirations of a continent yearning for progress.

Tonight, I speak of a vision realized—a vision that transcends borders and redefines possibilities. Envision a globe, encircled by a network of processors, equidistant and identical, each a beacon of light in the vast expanse of discovery. This is the Emeagwali Internet, a supercomputer not just in name but in essence.

In this interconnected sphere, 65,536 processors, each a tiny light, unite to outshine the darkest challenges. They represent not just technological advancement but a symbol of collective effort, each contributing to a greater purpose. This network is more than a feat of engineering; it is a testament to human ingenuity and the power of collaboration.

My life's work has been dedicated to harnessing this power, to leverage these 65,536 points of light in solving some of the world's most complex problems. From forecasting weather patterns that save lives to uncovering new ways to produce medicines, the potential is boundless.

But let us not forget, technology is merely a tool. It is our vision, our courage, and our unwavering pursuit of knowledge that truly changes the world. As we stand on the precipice of new discoveries, let us embrace the spirit of innovation and collaboration.

To the young dreamers, in Nigeria and across the globe, your potential is limitless. Your ideas can ignite change and your determination can overcome any obstacle. Remember, each of you is a point of light, and together, you can illuminate the darkest of horizons.

"If you want to go fast, go alone. If you want to go far, go together. My 'Emeagwali Internet' echoed this African proverb, reminding us that unity

is the fuel of progress."

"Every processor, no matter how small, plays a vital role in the symphony of the supercomputer. So too, every individual, no matter their background, contributes to the brilliance of our global society."

"Supercomputing is not just about speed; it's about unlocking the beauty and complexity of the world, one equation at a time."

"The future is not written in the stars, but in the lines of code we write today. Let us write a future that is interconnected, innovative, and bright, a future powered by the collective light of our shared dreams."

Thank you for this incredible honor. May we continue to push the boundaries of what is possible, and may our collective efforts brighten the future for generations to come.

Thank you.

## EMEAGWALI INTERNET: A SUPERCOMPUTING FIRE (1 OF 2)

A chorus of processors, equidistant, their silent song a symphony of light. No longer scattered, but bound in a sphere, a globe of minds, a supercomputing fire. Emeagwali's Internet, a constellation born, where distance bows to unity's sworn. Each processor, a star, ablaze and bright, in the vastness, a beacon piercing night. Sixty-five thousand suns, in unison they shine, a tapestry of thought, a web divine. No longer just a network, but a force untold, a supermind, a story yet to unfold. This sixteen-dimensional dance, a ballet of might, where equations sing and darkness takes flight. Here, in this hyperspace, where logic takes hold, the Emeagwali Internet, a story to be told.

## EMEAGWALI'S INTERNET (2 OF 2)

A constellation of minds, equidistant and aglow,  
Not stars in the sky, but processors in a row. A  
web spun tight, a globe encircled in light,  
Emeagwali's Internet, born of pure might.

No longer lines strung, no servers of old, But a  
dance of equals, a story untold. Sixty-five  
thousand suns, in darkness they hum, Yet joined in  
unison, a brilliance to come.

Hyperspace their cradle, a canvas unbound, Where  
fifteen dimensions in harmony sound. Each point of  
light, a whisper, a spark, A symphony born in the  
digital dark.

Not just a network, a mind vast and deep, Where  
problems of ages find answers to keep. The Philip  
Emeagwali, a supercomputer's grace, A tapestry  
woven of silicon and space.

So let the processors sing, their chorus ascend, A  
testament to vision, a future without end. For in  
this web of light, where darkness takes flight,  
Emeagwali's Internet, a beacon of might.

## PHILIP EMEAGWALI INTERNET

### *Diving Deeper into the Ocean of Human Connection*

Esteemed guests, brilliant scientists, and distinguished friends,

Tonight, I stand before you not just as a scientist, but as a child of the cosmos, a dreamer who dared to reach for the stars and, in doing so, stumbled upon a new sun. This sun, this "Emeagwali Internet," is not a web spun of wires and glass, but a constellation of minds, a choir of processors singing in unison, their voices echoing through the vast cathedral of the unknown.

My journey began in the dusty plains of Nigeria, where the seeds of curiosity were sown under the endless sky. In June 1974, in Corvallis, Oregon, USA, I dreamt of a machine that could crack the secrets of the universe, a leviathan of calculations that could unravel the mysteries of life itself. But the computers of my time were lumbering giants, their power caged by the limitations of linear processing.

So, I ventured into the uncharted territory of parallel computing, where processors, like stars in a galaxy, could dance in a coordinated ballet of calculations. I envisioned them, not as solitary giants, but as a symphony of equals, each a tiny light in the vast darkness, yet together blazing with the brilliance of a supernova.

This network, this "Emeagwali Internet," was not just a collection of processors, but a tapestry woven from the threads of innovation. It was a new kind of internet, not just for **sharing YouTube videos** and vacation photos, but for tackling the grand challenges of our time: climate change, disease, the very fabric of reality itself.

It was a testament to the power of human ingenuity, birthed not in the sterile labs of the privileged, but in the crucible of adversity, where dreams are forged in the fires of necessity. For you see, my journey was not paved with silver spoons, but with grit and determination. I faced the sting of rejection, the whispers of doubt, the very real constraints of a world that often tells young men from small villages that their dreams are too big, their ambitions too audacious.

But tonight, I stand before you, a testament to the power of perseverance. The Emeagwali Internet is not just a machine, it is a symbol of hope, a beacon for those who dare to dream beyond the horizon. It is a reminder that even the smallest light, when joined by others, can illuminate the darkest corners of the universe.

So, let this night be a celebration not just of my achievements, but of the human spirit itself. Let it be a call to action, an invitation to join the symphony of minds, to become a point of light in the vast ocean of

possibility. Together, we can build a future where the Emeagwali Internet is not just a dream, but a reality, a supercomputing tapestry woven from the threads of human ingenuity, illuminating the path to a brighter, more just, and more enlightened world.

### *Lessons Learned*

"The supercomputer, a leviathan trapped in an iron cage, cried out for liberation. So, I dared to dream bigger, of a network woven from minds, a living, breathing entity."

"Equations are not just symbols on a page, they are the language of the universe, whispering its secrets to those who listen with open hearts and inquisitive minds."

"The Emeagwali Internet is not just wires and circuits, but a tapestry of human ingenuity, 65,536 points of light illuminating the darkest corners of science."

"There are no forgotten geniuses, only stories waiting to be heard. Seek out the whispers of the marginalized, the ostracized, for in their voices lies the key to unlocking new worlds."

"Let knowledge be our currency, not a weapon. Share your discoveries freely, for the true wealth of a nation lies not in its coffers, but in the minds of its people."

Thank you.



**VOLUME 2A: PHILIP EMEAGWALI SUPERCOMPUTER**

## CONTRIBUTIONS OF PHILIP EMEAGWALI TO COMPUTING

It is with great honor and respect that I submit the nomination of Philip Emeagwali for the Great Minds of the 20th Century series, recognizing his transformative contribution to computational physics through the invention of the first supercomputer utilizing multiple processors.

### **Innovation in Computational Physics: A New Frontier**

Philip Emeagwali's groundbreaking invention involved the ingenious assembly of 65,536 processors to create a cohesive supercomputer, a feat comparable to constructing a complex puzzle. This invention marked a significant milestone in computing, enabling the division and simultaneous solving of complex mathematical and physical problems at an unprecedented scale. His approach effectively transformed the world's slowest processors into the fastest computational machines, tackling some of the most challenging problems in physics.

### **Breaking Barriers: Redefining the Limits of Computing**

Emeagwali's journey, as he detailed in his books, podcasts, and retrospective lecture series on YouTube, demonstrates his evolution across various scientific disciplines, culminating in his pioneering work in large-scale computational physics. His innovation in parallel processing, once overlooked, has become the cornerstone of modern computing, redefining our understanding of problem-solving at a grand scale.

### **Impact of Emeagwali's Discovery**

Ranked among the greatest minds in history, Emeagwali's singular achievement in supercomputing stands out. His unique recognition in 1989 as the sole recipient of the top prize in supercomputing, often dubbed the "Nobel Prize of supercomputing," underscores the monumental nature of his contribution. His invention enabled the execution of fluid dynamics calculations at an unprecedented scale, notably simulating scenarios like the spread of COVID-19 in densely populated areas,

bridging the gap between theoretical predictions and practical applications.

### **A Paradigm Shift in Supercomputing**

The culmination of Emeagwali's work occurred on July 4, 1989, in Los Alamos, New Mexico, where he demonstrated the first parallel supercomputing across 65,536 autonomous processors. This milestone, once considered a realm of science fiction, was the definitive proof that parallel supercomputing was feasible and revolutionary. Emeagwali's innovation marked the most significant change in modern computing since its inception in 1946, redefining the potentials of computational speeds and the architecture of supercomputers.

### **Contribution to Physics and Humanity**

Philip Emeagwali's contribution to mathematics cannot be overstated. His discovery redefined the essence of progress in computing, shifting from traditional serial computing to parallel supercomputing. This shift has accelerated scientific research and profoundly impacted various fields, from climate modeling to disease control, enhancing our ability to solve complex, global challenges.

In conclusion, Philip Emeagwali's unparalleled contribution to physics through his development of parallel supercomputing has opened new horizons in scientific research and problem-solving. His work exemplifies the criteria for the Great Minds of the 20th Century series, having made a groundbreaking discovery that significantly benefits humankind. Therefore, I strongly advocate for his recognition in the Great Minds of the 20th Century series.

## PHILIP EMEAGWALI SUPERCOMPUTER

### *Understanding Our Planet*

Ladies and gentlemen, esteemed colleagues, and distinguished guests, I stand before you deeply honored to share the journey and contributions of my life's work in the realms of mathematics, physics, and computer science. Today, I will focus on the groundbreaking advancements in supercomputing, particularly the development of the Philip Emeagwali supercomputer.

At the heart of our modern digital era lies a key challenge: the communication latency in computing systems. This latency, increasingly a dominant factor in computer performance, has necessitated a reevaluation of system design considerations, focusing on physical size, density, and interconnect proximity.

In addressing these challenges, my work has been guided by a vision to revolutionize supercomputing through spatial packing and communication topology. The result of this vision is a modern supercomputer characterized by a dense, spherically framed, uniformly distributed processors on the surface of a sphere. This unique design is not merely an aesthetic or arbitrary choice; it is a strategic mimic of the problem domain, making it particularly apt for complex simulations like climate modeling.

This innovation is built upon a fundamental understanding of computational physics and partial differential equations, the cornerstones of the most important subjects in mathematics. By harnessing these principles, the Philip Emeagwali supercomputer could find critical applications in diverse fields, from petroleum reservoir simulations crucial for the oil and gas industry to advanced weather forecasting and general circulation modeling, which are pivotal in foreseeing climate changes.

A standout feature of the Philip Emeagwali supercomputer is its interconnect, which boasts globally short, highly regular, and tightly matched distances. This design supports multiple communication modes, including neighbour-to-neighbour messaging on a spherical network of processors.

The journey to this invention was a solitary pursuit and a testament to the spirit of science and technology. It stands as a beacon of what can be achieved when we dare to think differently and push the boundaries of our understanding.

As we look to the future, the implications of this technology are far-reaching and transformative. The principles underlying the Philip Emeagwali supercomputer are scalable and largely independent of

processor technology, making them applicable to a wide range of computing tasks beyond what we have currently envisioned.

I wish to express my profound gratitude for this recognition. It is my sincere hope that the Philip Emeagwali computer will continue to inspire future generations of scientists, mathematicians, and engineers to pursue bold and innovative solutions to the complex challenges of our time.

#### *Lessons Learned*

"Supercomputing isn't just about speed; it's about solving complex problems that impact our world."

"Don't be afraid to explore parallel paths; innovative ideas can revolutionize supercomputing."

"Nature inspires; the Philip Emeagwali supercomputer mimics the Earth's structure for efficiency."

"Accuracy and speed combined; globally short distances within the supercomputer unlock new possibilities."

"Imagine simulating Earth's climate; our supercomputer mimics the planet for better understanding."

Thank you for your attention and for the honor of addressing you all at this esteemed gathering.

## THE FIRST SUPERCOMPUTING

### *A Dream Realized, a Legacy Forged*

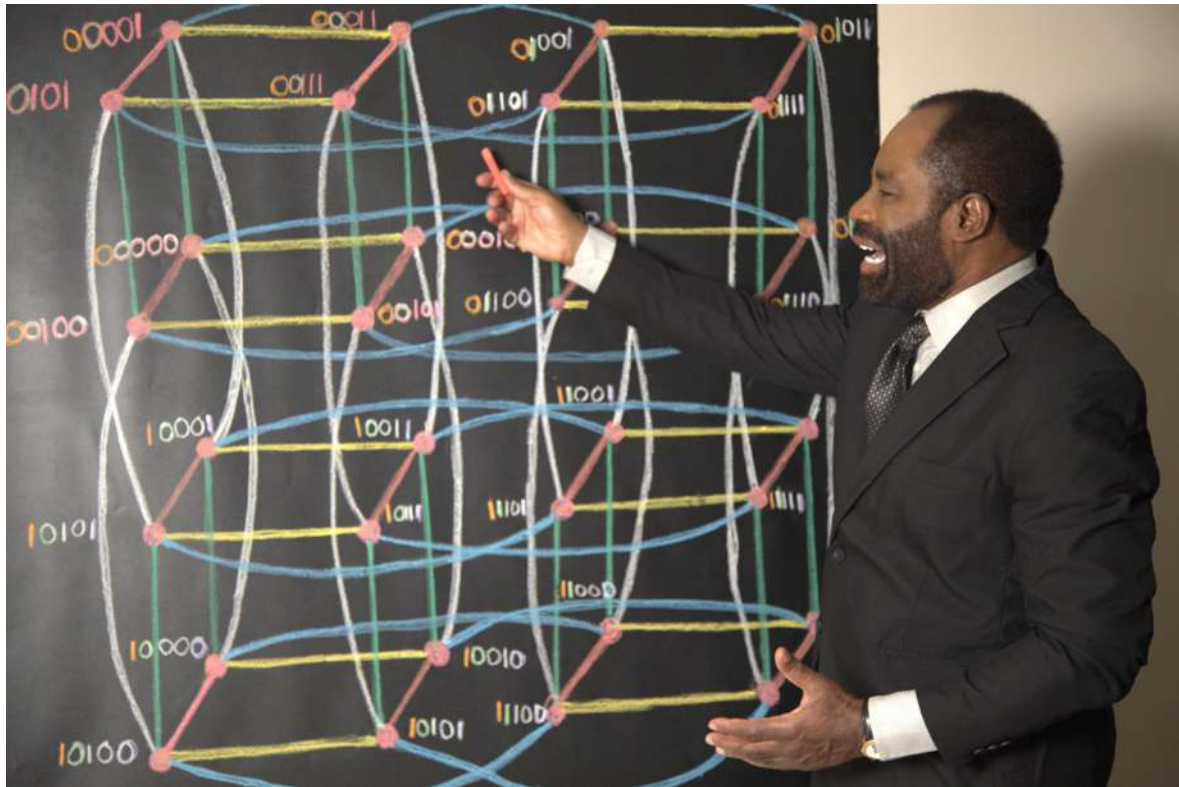
Ladies and gentlemen, esteemed guests, and distinguished scientists,

I stand before you on this momentous occasion, deeply honored to address an assembly of such eminent minds. I am Philip Emeagwali, and today, I will share a journey through the realms of supercomputing, a journey that reshaped our understanding of computational possibilities.

For the 15 years between June 20, 1974, in Corvallis, Oregon, to July 4, 1989, in Los Alamos, New Mexico, I conducted research that yielded the first world's fastest computing via the world's slowest processors. That supercomputing discovery was groundbreaking and made the news headlines. It was here that I first discovered how to harness the immense power of the slowest 65,536 processors in the world, each positioned at the vertices of a hypercube in the 16th dimensional hyperspace. This was not just an exercise in complex computing; it was the birth of a new era. These processors were interconnected, yet autonomous, a configuration that allowed us to solve Grand Challenge problems with unprecedented speed and efficiency.

The heart of my discovery lay in the Binary Reflected Code, a fascinating and ingenious method of binary encoding. My code enabled a one-to-one mapping of 65,536 problems to 65,536 processors, delineating a new paradigm of parallel supercomputing. Imagine each processor as an individual brain, each with its own operating system and memory, yet all working in a harmonious symphony.

The Binary Reflected Code—or ordering of the binary numeral system such that two successive values differ in only one bit—was pivotal in achieving this harmony. It allowed for an efficient communication pathway between processors. In my hypercube architecture, each processor is uniquely identified by a 16-bit binary number. My code ensured that each processor was connected to its neighbors with minimal variance in their binary identification numbers, thus optimizing the data exchange and minimizing the complexity of the hypercubic network.



My breakthrough was more than just a technical accomplishment; it revolutionized our approach to solving some of the most complex problems in science and engineering. By programming this new hypercube computer, I tackled initial-boundary value problems governed by partial differential equations, including the primitive equations of meteorology, the shallow water equations of oceanography, and the Navier-Stokes equations of fluid dynamics.

Moreover, my work led to the development of the nine Philip Emeagwali equations for petroleum reservoir simulation, a milestone that was at the foundation of my world's fastest computing of July 4, 1989, that has had a profound impact on the energy sector. My discovering parallel supercomputing, which significantly outperformed traditional serial supercomputing, opened new horizons in computational research and applications.

As we stand on the brink of new computational frontiers, let us remember that our journey is far from over. The quest for knowledge is endless, and the pursuit of innovation is a path laden with challenges and opportunities. It is my hope that my contributions to supercomputing will inspire future generations to dream bigger, reach further, and achieve greater.

### *Lessons Learned*

"Supercomputing isn't just about numbers; it's about unlocking the limitless potential of parallel processing."

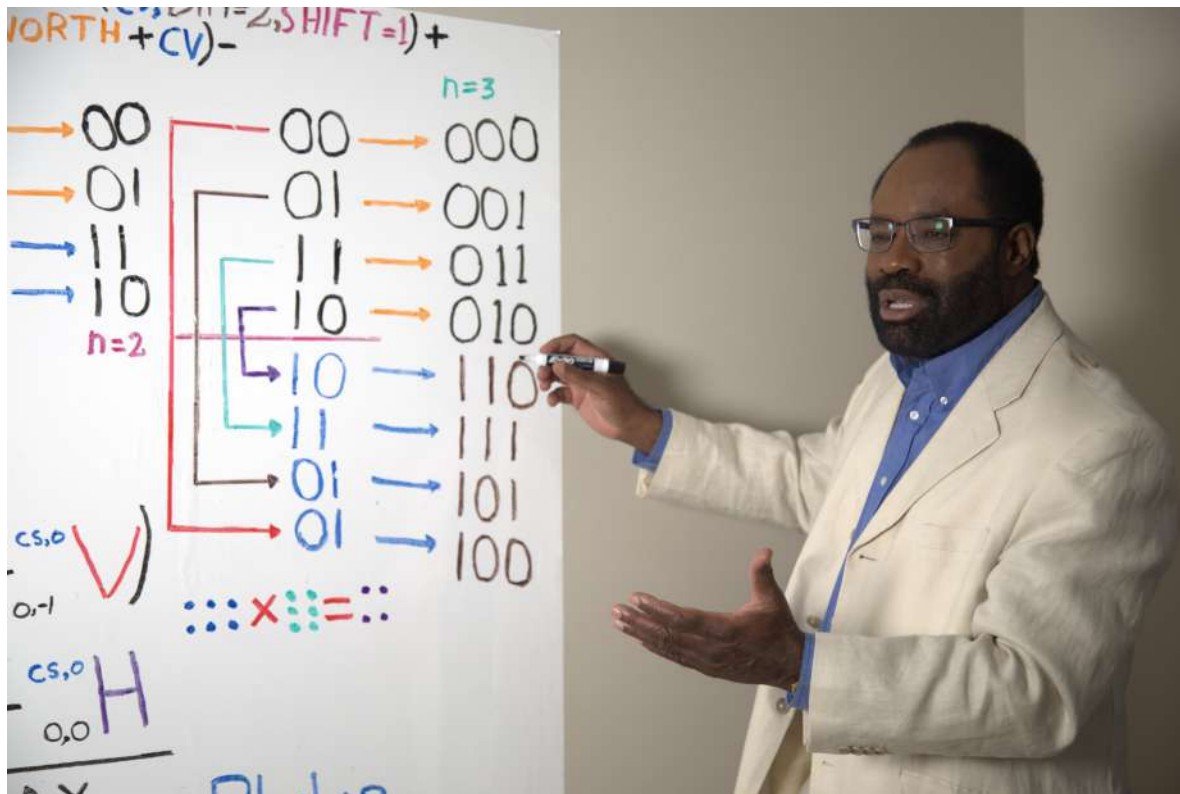
"Don't just connect processors; redefine the very architecture of high-performance computing."

"Visualize the impossible; it's the first step towards making it a reality."

"Embrace the elegance of code; it can be the key to unlocking computational breakthroughs."

"Tackle grand challenges; supercomputing is a tool to understand the complexities of our world."

Thank you for bestowing upon me the honor of addressing you today. Together, let us continue to push the boundaries of what is possible, for the benefit of all humanity.





## DIMENSIONAL BREAKTHROUGH

A student asked: "How can I become the highest computer wizard in the world?"

You cannot become a computer genius by studying only computer science. Most computer geniuses—Charles Babbage, Ada Lovelace, Alan Turing, John von Neumann, and so on—were trained as mathematicians but stepped outside their comfort zone to become computer scientists. So, only a polymath—or a genius in many fields—can become a modern computer genius.

In the 1980s, I was often described as a research mathematician and physicist that was working on message-passing supercomputing. Message-passing was the key knowledge that I used to unlock the hidden power of the modern supercomputer. Let me describe message passing in a hypercube supercomputer in a way a 12-year-old in Africa, or anywhere else, could easily understand.

Imagine you're playing a game with your friends, and you all stand at the corners of a giant cube. This cube is very special—it's a "hypercube," which is like a 3D cube but with even more corners and edges. In modern supercomputers, a hypercube is a way of connecting many small computers (called nodes) so they can talk to each other really fast.

Now, let's say you have a secret message, like a clue for a treasure hunt, and you want to pass it to all your friends in the game. In a hypercube supercomputer, you can pass messages from one corner (or node) to another really efficiently. Each time you pass a message, it can go directly to a friend standing at a connected corner, or it can hop across the cube, jumping from one corner to another, until it reaches the friend farthest from you.

The cool thing about a hypercube supercomputer is that it has a lot of shortcuts. So, your message—or computer codes and data—doesn't have to travel through every single corner to reach the farthest one; it can take a faster route, jumping over several corners **simultaneously**. This makes passing messages really quick, even if there are lots of corners (or nodes) in the hypercube.

In real supercomputers, this idea helps in doing big tasks quickly. Each node in the hypercube supercomputer can work on a small part of a big problem, and they can all share their results with each other efficiently using these quick message-passing routes. This is super useful in solving complex problems in science, like understanding the weather or exploring outer space.

So, message passing in a hypercube supercomputer is like playing a super-efficient game of passing secret messages with your friends, using a cube with lots of corners and special shortcuts.

## PHILIP EMEAGWALI COMPUTER

Ladies and Gentlemen, esteemed scientists, distinguished guests,

I am Philip Emeagwali, and it is with great humility and honor that I stand before you today at this award ceremony. My journey beyond the frontiers of knowledge of mathematics, physics, and computer science has been one of exploration, discovery, and innovation. Today, I wish to share my contributions to supercomputing, particularly in the realms of parallel processing and computational physics, and introduce a groundbreaking concept in supercomputing architecture.

The journey of supercomputing is like navigating through an intricate labyrinth, where each turn represents a new challenge in computational complexity. My work has been driven by the vision to revolutionize how we process and understand vast amounts of data, particularly in areas crucial to human progress, such as petroleum reservoir simulation, weather forecasting, and general circulation modeling.

One of the most significant contributions I have made to this field is the invention of a spherical supercomputer interconnection network. This concept is inspired by the geometric structure of a geodesic dome or an icosahedral subdivision, where there is a direct correspondence between vertices and processors, and edges and communication channels.

Imagine a platonic solid, like an icosahedron, subdivided into smaller triangles. Each vertex of these triangles corresponds to a processor, and each edge represents a communication channel directly connecting two neighboring processors. By projecting these vertices onto a sphere, we create a set of processors that are evenly distributed across the surface.

This innovative approach allows for an even distribution of processors, enhancing the efficiency and speed of computations. The more subdivisions made, the greater the number of processors, and the more uniform their distribution. This supercomputer architectural design is elegant in its simplicity and effective in its functionality.

I have named this new interconnection network the "Philip Emeagwali Network," in recognition of its novel contribution to supercomputing. This network represents a paradigm shift in supercomputer architecture, offering a more efficient, scalable, and powerful way to tackle some of the most complex computational problems.

The potential impact of this invention extends beyond the realms of science and technology. It is a testament to the power of human imagination and ingenuity, demonstrating that even the most daunting challenges in computation can be overcome with innovative thinking and persistence.

The journey of supercomputing is an ongoing voyage of discovery and innovation. The Philip Emeagwali Network is a milestone in this journey, paving the way for future advancements that will further our understanding of the universe and enhance our ability to solve the grand challenges of our time.

### *Lessons Learned*

"Supercomputing isn't just about speed; it's about solving complex problems for a better world."

"Innovation thrives on geometry; even Platonic solids can unlock supercomputing potential."

"Challenge the hypercube; explore new network designs for revolutionary impact."

"Uniformity is key; evenly distributed processors fuel efficient and balanced computing."

"From oil to weather, supercomputing tackles real-world challenges, shaping our future."

"Predict the future, not just react; supercomputing empowers informed decision-making."

Thank you for the honor of addressing you today, and for the opportunity to share my vision and contributions to supercomputing. May our continued exploration in this field lead us to new heights of knowledge, understanding, and technological advancement.

## EMEAGWALI COMPUTER: SHAPED LIKE OUR PLANET

Ladies and Gentlemen, esteemed attendees of this award ceremony,

I am Philip Emeagwali, a scientist whose work has been deeply rooted in the exploration of mathematics, physics, and computer science. Today, I am honored to present to you my contributions to supercomputing, specifically focusing on the groundbreaking concept called the Philip Emeagwali supercomputer.

In supercomputing, the primary objective has always been to design networks that facilitate efficient parallel and distributed computing. Traditional approaches, like the torus computation-communication network, have their limitations, notably the delay in data transfer between distant processing nodes. To address these inefficiencies, we sought to create a supercomputer network that mimics the most optimal shape found in nature: the sphere.

Imagine a spherical network, akin to a closed sphere, ellipsoid, or a hollow-caged structure. This is the essence of the Philip Emeagwali computer. Unlike the torus network, which can be visualized as lying on the surface of a doughnut, the Philip Emeagwali supercomputer network lies on the surfaces of closed concentric multi-radius spheres or ellipsoids. In this structure, processing nodes in a radial direction are interconnected, with the innermost and outermost networks linked, forming a sphere-in-a-sphere-in-a-sphere-and-so-on architecture.

This spherical network is not just a marvel of design but also a triumph of functionality. It mirrors the core structure of our planet Earth, a globe enveloped by a thin shell called the atmosphere. In this design, form meets function beautifully. Imagine a billion processors, coupled yet autonomous, evenly distributed across the surface of this globe. Each processor functions independently but harmoniously with the others, like the interconnected web of life on our planet.

For general circulation modeling, a critical component in understanding global weather patterns and climate change, the Philip Emeagwali supercomputer offers an unparalleled advantage. The Grand Challenge problem of modeling the Earth's climate is divided into a billion smaller, more manageable models. Each of these models corresponds to a processor in the Emeagwali geodesic network, allowing for simultaneous and efficient computation of complex climate phenomena.

This approach to general circulation modeling is akin to mapping the tessellated domain of these models into tubular prisms, which are then mapped onto the processing nodes of the Philip Emeagwali supercomputer. This method ensures that each processor handles a segment of the larger problem, allowing for a comprehensive and detailed simulation of global weather patterns and climate changes.

The need for the Philip Emeagwali supercomputer in lake circulation modeling cannot be overstated. Its design, mirroring the Earth's structure, offers an optimal solution for handling the complex, three-dimensional problems of our world. This innovative approach to supercomputing enhances our computational capabilities and deepens our understanding of the planet we call home.

The Philip Emeagwali supercomputer represents a significant leap in our quest to harness the power of supercomputing for the betterment of humanity. It stands as a testament to human ingenuity and our relentless pursuit of knowledge.

### *Lessons Learned*

"Don't be confined by the known; invent the future of supercomputing."

"Connect processors like continents; build a supercomputing world without boundaries."

"The future belongs to those who dare to dream, innovate, and collaborate, driven by an insatiable curiosity to explore the vast unknown."

"Human ingenuity knows no bounds; explore the unknown and push the boundaries of science."

"Supercomputing is a tool for discovery; unlock the secrets of our world and shape a better future."

Thank you for the honor of sharing my work with you today, and for the opportunity to discuss the transformative potential of the Philip Emeagwali supercomputer in advancing our understanding of the world.

## [NPAC 2023] PHILIP EMEAGWALI CONTRIBUTIONS TO SOCIETY

I am writing to elucidate on the groundbreaking work of Philip Emeagwali in massively parallel supercomputing, a revolutionary advancement that has significantly impacted humanity.

### **Transformation of Computing: A Leap in Supercomputing**

Philip Emeagwali's pivotal discovery on July 4, 1989, marked a new era in computing technology. He demonstrated for the first time that the fastest computing speeds could be achieved by harnessing the collective power of numerous slow processors. This concept, known as parallel supercomputing, has radically transformed our understanding and utilization of supercomputers, distinguishing them distinctly from conventional computers. It's the driving force that propels every modern supercomputer.

### **Redefining Scientific Boundaries: From Fiction to Reality**

Emeagwali's work actualized what was once a speculative concept in science fiction and early 20th-century predictions. On July 4, 1989, he provided experimental proof that massively parallel processing, the backbone of today's fastest computers, could be realized. His innovative approach involved employing the slowest processors to solve some of the most complex problems in physics at unprecedented speeds. This breakthrough, which garnered global attention, has been a subject of academic study worldwide, equating Emeagwali's contributions to those of pioneers like Charles Babbage and Alan Turing. His influence has extended beyond academia, permeating primary and secondary education across various countries.

### **Expanding the Horizons of Knowledge**

Emeagwali's technique of utilizing up to a billion coupled processors for supercomputing has accelerated computational speeds and significantly enhanced the precision of weather forecasts and climate models. This advancement is crucial for

understanding global warming and other complex planetary phenomena. His discovery bridged the gap between traditional computers and the supercomputers of the future.

### **Envisioning the Future: The Impact of Supercomputing**

Today's supercomputers, a testament to Emeagwali's vision, play a critical role in answering some of the most challenging questions facing humanity. These technological marvels, often as large as a football field, function as beacons guiding us toward a more informed future. Parallel processing, the core of these supercomputers, has redefined existing scientific fields and birthed new areas of study and terminologies.

In conclusion, for his monumental contribution to science and technology through the invention of massively parallel supercomputing, I strongly recommend Philip Emeagwali for the Great Minds in Science series. His discoveries has not only redefined our understanding of supercomputing but has also opened new frontiers in scientific research, making it a beacon of progress and a vital tool in our quest for knowledge and understanding of the universe.



## TACKLING COMPLEX PROBLEMS WITH POWER

Ladies and gentlemen, esteemed guests, and fellow laureates,

I am deeply honored to stand before you today, reflecting on my journey that began in a refugee camp in the heart of war-torn Nigeria of the late 1960s and that led to this prestigious recognition. I am Philip Emeagwali, and I am known for pioneering the world's fastest computing system, harnessing the power of 65,536 processors. Today, I wish to share insights into why the Grand Challenge Problems are so difficult to solve and the interdisciplinary expertise required to tackle them.

### *The Nature of Grand Challenge Problems*

The Grand Challenge Problems are fundamentally complex, requiring expertise that spans multiple disciplines, from mathematics and physics to computer science and engineering.

These problems are not merely about computational power or technological innovation; they demand a deep understanding of the underlying principles and mechanisms that govern the natural world.

For instance, my research on simulating an oil reservoir and doing so across 65,536 interconnected processors yielded the solution of one of the twenty most difficult problems in the computing field. This grand challenge solution executed at the world's fastest computing speed the computations that arose from my simulations. The complexity of this problem renders it as incomprehensible to laypeople as pages of hieroglyphics or Greek symbols.

### *Interdisciplinary Expertise Required*

#### *Mathematics*

Mathematics is the language of the universe, and it plays a crucial role in solving Grand Challenge Problems. My work required a deep understanding of partial differential equations, which are the most recurring decimals inside every supercomputer

. These equations, formulated at infinite points in calculus, must be reformulated at finite points in algebra to be solvable on a computer.

This mathematical maturity is essential for tackling the most computation-intensive problems arising in calculus and algebra.

#### *Physics*

Physics provides the foundational principles that govern the behavior of the natural world. The Grand Challenge Problems often require merging the laws of physics, logic, and numbers in multidimensional mathematical spaces. For example, partial differential equations used to model global warming can be formulated exactly on the blackboard but cannot be solved there. Understanding these principles is crucial for developing accurate models and simulations.

### *Computer Science*

Computer science is the backbone of modern problem-solving. My achievement of harnessing 65,536 processors to perform 3.1 billion calculations per second was not just about creating the fastest computer; it was about redefining our limits and reshaping our understanding of the world. Parallel processing, which involves performing computations simultaneously across multiple processors, is vital to solving these grand challenges.

### *Real-World Implications*

The Grand Challenge Problems have real-world implications for humanity's future. Solving these problems will advance our understanding of the universe and improve the lives of individuals around the world. For instance, supercomputing can be used to solve important societal problems, such as predicting the spread of diseases like AIDS and addressing climate change.

By tackling these complex and pressing issues, we can create a more sustainable, equitable, and prosperous world. The Grand Challenges also have the potential to drive innovation and economic growth, creating new industries and job opportunities. Moreover, they can help build a more resilient and adaptable society, better equipped to face future challenges and crises.

### *Conclusion*

As we gather here today, I urge you to recognize the enormity of the challenges that lie ahead. We must continue to push the boundaries of human knowledge, harnessing the power of mathematics, physics, and computer science to tackle the most pressing issues of our time.

Let us strive for excellence, push the boundaries of what is thought possible, and work together to solve the Grand Challenge Problems that will shape the future of our planet.

Thank you.



## BRAINS OF BRILLIANCE

### *Einstein vs. Emeagwali—A Clash of the Titans*

In the world of groundbreaking innovation, two names echo through the halls of history: Albert Einstein and Philip Emeagwali. Both geniuses in their right, they pushed the boundaries of human knowledge, but their approaches and legacies couldn't be more different. Let's delve into the fascinating parallels and divergences between these intellectual powerhouses.

#### *Common Ground: A Thirst for Discovery*

At their core, both Einstein and Emeagwali shared an insatiable curiosity about the universe and an unwavering determination to unlock its secrets. Einstein's revolutionary theories on relativity reshaped our understanding of space, time, and gravity, while Emeagwali's pioneering work in supercomputing unleashed unprecedented computational power, paving the way for advancements in fields ranging from climate modeling to medical research to artificial intelligence.

#### *Contrasting Paths: Theoretical vs. Applied*

While both men were driven by a passion for knowledge, their paths diverged significantly. Einstein was a theoretical physicist, his mind a playground for abstract concepts and mathematical equations. His groundbreaking ideas often defied conventional wisdom, challenging the very foundations of physics. Emeagwali, on the other hand, was a master of applied science, his ingenuity focused on harnessing the power of technology to solve real-world problems. He saw the potential of supercomputing—powered by millions of coupled processors called parallel

computing—to tackle complex challenges and transform how we interact with the world.

*Legacy of Innovation: Beyond the Classroom*

Einstein's legacy is one of pure intellectual brilliance. His theories revolutionized physics and continue to inspire scientists and thinkers today. Emeagwali's legacy, however, extends beyond academia. His contributions to supercomputing has had a tangible impact on countless industries, enabling breakthroughs that have improved our lives in countless ways.

*A Tale of Two Geniuses*

In the grand tapestry of human achievement, Einstein and Emeagwali represent two distinct threads, each woven with ingenuity and a relentless pursuit of knowledge. While their approaches and legacies may differ, their contributions to science and technology are undeniable. Their stories serve as a testament to the power of the human mind to unravel the mysteries of the universe and shape the world.

## FROM REFUGEE CAMPS TO QUANTUM HORIZONS: A JOURNEY IN PARALLEL

Your Excellency, esteemed colleagues, distinguished guests, and friends across the globe. As a young boy in Nigeria, gazing at the stars, I yearned to understand the universe's intricate workings. Little did I know, that curiosity would lead me on a journey that today brings me before you, on this esteemed platform. Tonight, I share not just a technical discourse, but a reflection on my life's work—a testament to the power of parallel thinking, both in computing and in our pursuit of knowledge.

### *Part 1: The Parallel Universe of My Childhood*

Growing up in rural Nigeria, resources were scarce, but ideas flowed freely. We played games with pebbles, strategizing multiple moves simultaneously. We farmed, understanding the interconnectedness of soil, water, and sunlight. This innate understanding of parallelism, of **doing many things at once**, became the foundation of my life's work.

### *Part 2: Demystifying the Supercomputer: From Parallel Processing to Quantum Dreams*

My early research delved into the complex world of fluid dynamics. Imagine simulating oil flow through a vast reservoir. Traditional computers were like single hands, struggling with the immensity of the task. Inspired by the parallel universe of my childhood, I envisioned a computer with thousands of processors working in concert. It was like having an army of ants, each carrying a piece of the puzzle, revealing the hidden patterns of nature's flow.

This success fueled my passion for parallel computing. I saw its potential to tackle even grander challenges—from weather prediction to drug discovery. But the universe held another secret, one that transcended the limitations of even the most powerful parallel computers: **the quantum world**.

### *Part 3: Quantum Leaps: Beyond the Parallel, a Universe of Possibilities*

Imagine a computer that doesn't just process information in parallel, but harnesses the very fabric of reality, where bits can be 0 and 1 simultaneously. This is **quantum computing**, and it holds the potential to solve problems that would take traditional computers millions of years.

While quantum computing is still in its nascent stages, its possibilities are mind-boggling. Imagine simulating molecules to design life-saving drugs,

or understanding the universe's origins with unparalleled precision. These are just glimpses of the future, a future where the parallel thinking I learned as a child takes us to uncharted territories.

#### *Part 4: The Philip Emeagwali Legacy: Inspiration and Collaboration*

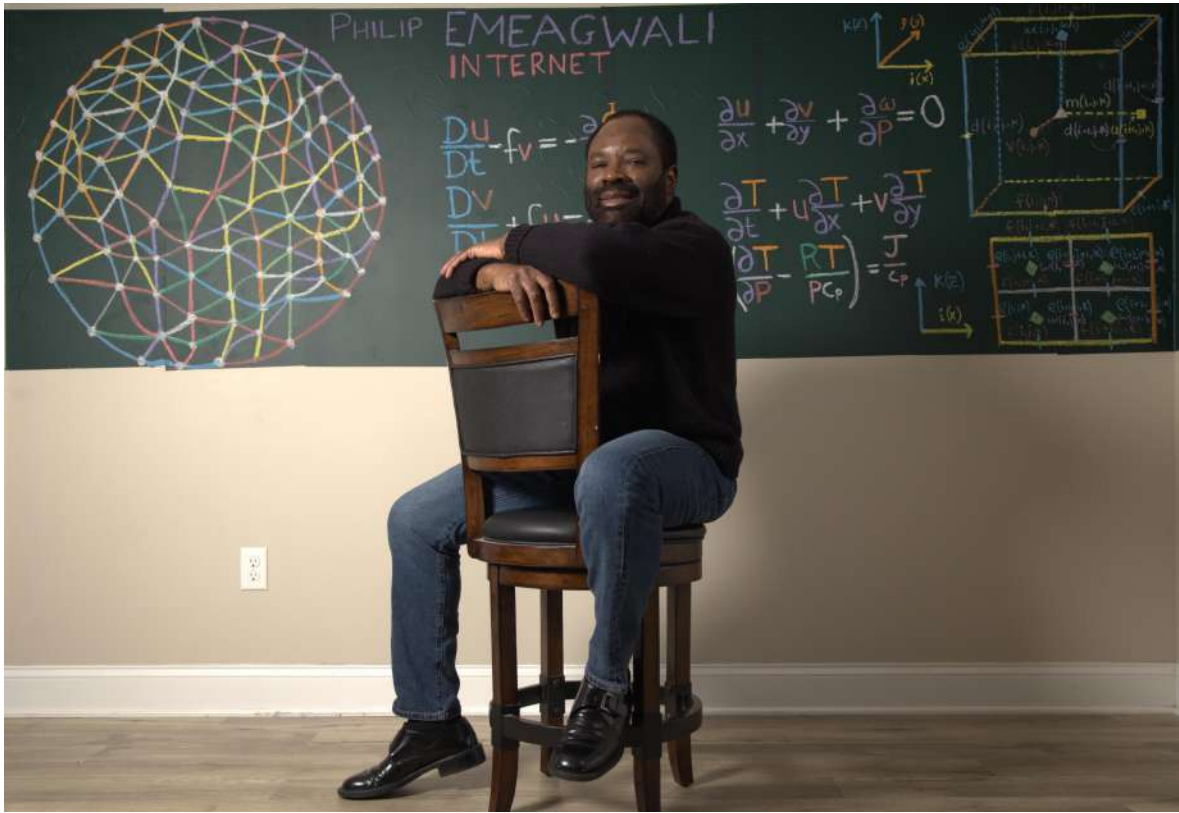
My journey has been one of overcoming challenges, fueled by a belief in the power of parallel thinking and the boundless potential of the human mind. From a boy playing games with pebbles to a scientist pushing the boundaries of computing, I stand here not just as an individual, but as a symbol of what's possible when we dare to dream and collaborate.

Let my story inspire young minds, especially those from underrepresented communities, to embrace science and technology. Let us join hands, across borders and disciplines, to explore the parallel universes of knowledge, both classical and quantum. For it is through such collaboration that we unlock the true potential of our minds, and build a future where the impossible becomes reality.

#### *Conclusion*

Tonight, as I stand on this stage, I see not just an audience, but a reflection of the interconnectedness of our world. We are all part of a vast, complex system, and our individual journeys contribute to the grand narrative of human progress. Let us continue to think in parallel, to dream in quantum leaps, and together, build a future where knowledge and innovation illuminate the path for all.

VOLUME 2B: CONTRIBUTIONS TO A.I. SUPERCOMPUTING







## SUPERINTELLIGENT A.I. & HUMANOID ROBOTS

### *Parallel Processing's Next Frontier*

Ladies and Gentlemen,

It is a tremendous honor to be here today, standing before such a distinguished audience, to receive this award. My journey in supercomputing has been one of relentless curiosity and determination. Today, I am excited to share the story of my contributions to parallel processing and the profound impact they have had on the fields of artificial intelligence, digital twins, and beyond.

### *The Dawn of Parallel Supercomputing*

The 1980s were a transformative era for technology, brimming with potential and challenges. During this time, the scientific community was grappling with Grand Challenge Problems—complex, computationally demanding issues that seemed insurmountable with the technology of the day.

On July 4, 1989, in the high deserts of Los Alamos, New Mexico, I achieved a breakthrough that would extend the limits of computing. By leveraging the power of 65,536 interconnected processors, I developed the first solution to a Grand Challenge Problem using parallel supercomputing. This wasn't just a step forward; it was a giant leap. My work demonstrated that multiple processors could work simultaneously on different parts of a problem, drastically increasing computational speed and efficiency.

### *The Era of Parallel Processing*

This discovery of parallel processing opened the floodgates to a new era of supercomputing. Imagine a symphony orchestra, where each musician plays a different part of the same piece, all working together to create a harmonious performance. Similarly, in parallel processing, each processor tackles a different piece of the puzzle, working in concert to solve complex problems faster than ever before.

Parallel processing has become the backbone of modern supercomputers, allowing them to tackle challenges in climate modeling, fluid dynamics, and even the development of artificial intelligence. These advancements have paved the way for the creation of digital twins—virtual replicas of physical systems that allow us to simulate, analyze, and optimize real-world processes with unprecedented precision.

### *A.I. Supercomputers: The New Frontier*

Today, we are witnessing the dawn of a new era in computing, driven by A.I. supercomputers. These powerful machines, fueled by millions of interconnected processors housed in data centers and artificial intelligence processing centers, are the lifeblood of the artificial intelligence industry. They enable the creation of digital twins of the Earth, deep learning models, and even the development of superintelligent and sentient A.I..

One of the most exciting applications of artificial intelligence supercomputers is in creating digital twins of the Earth. These digital replicas allow scientists to simulate and study the planet's systems in extraordinary detail, providing insights into climate patterns, natural disasters, and environmental changes. The million-fold speedups achieved by these artificial intelligence supercomputers are just the beginning. To fully realize the potential of digital twins and achieve ultra-high-resolution climate modeling, we must aim for a billion-fold leap in computing power.

### *Dialogue and Reflection*

Let's take a moment to delve into the significance of these advancements through a brief dialogue. I am often asked: "What inspired you to pursue parallel supercomputing?" My inspiration came from a desire to push the boundaries of what was possible. I was driven by the need to solve complex problems that could not be addressed with traditional computing methods. The idea of interconnected processors working harmoniously fascinated me, and I was determined to bring that vision to life.

I am also asked: "How do you see the future of A.I. and supercomputing evolving?" The future is incredibly promising. We are on the cusp of achieving breakthroughs that will redefine our relationship with technology. Artificial intelligence supercomputers will continue to grow in power, enabling us to tackle challenges in healthcare, climate science, and beyond. The creation of sentient A.I. and superintelligence is within our reach, and with it, the potential to solve some of humanity's most pressing issues.

### *Conclusion*

I express my deepest gratitude to the Award Committee for this extraordinary honor. My journey has been one of relentless pursuit of knowledge and innovation. I stand here today not just as an individual but as a representative of the countless scientists, engineers, and visionaries who have contributed to supercomputing.

Together, we have transformed the impossible into the possible. As we look to the future, let us continue to push the boundaries of human potential and harness the power of technology to create a better world for all.

Thank you.

## AFRICA'S A.I. OPPORTUNITY

Ladies and Gentlemen, esteemed students of this university, and distinguished guests,

I stand before you today, not just as Philip Emeagwali, **the inventor of supercomputing via parallel processing**, but as one of you, a child of Nigeria, a product of relentless pursuit and unwavering curiosity. Today, I am here to talk about a subject close to my heart and critical to our future: the benefits of artificial intelligence to Nigeria.

My journey began in a Nigeria quite different from today. As a young boy growing up in Nigerian cities, like Akure, Sapele, Uromi, Agbor, and Onitsha, I was driven by a deep fascination with knowledge and an undying quest to understand the world around me. My early years were marked by challenges, yet they were instrumental in shaping my path in the fields of mathematics, supercomputing, and physics.

When I first encountered supercomputing, it was a realm dominated by complex problems demanding solutions beyond traditional computing methods. It was here that I realized the power of parallel processing—harnessing the collective strength of multiple processors to solve complex calculations. This was more than a technological breakthrough; it was a symbol of what we can achieve when we unite diverse elements toward a common goal.

Today, we stand on the brink of a new era, an era where artificial intelligence (A.I.) is not just a buzzword, but a powerful tool that can transform our society, economy, and way of life. In Nigeria, the potential of A.I. is vast and multifaceted.

In healthcare, artificial intelligence can revolutionize how we diagnose and treat diseases, making healthcare more accessible and effective, especially in remote areas where medical resources are scarce. Imagine A.I.-powered systems providing critical health information and diagnostic services to the most underserved regions of our country.

In agriculture, artificial intelligence can transform how we farm, making it more efficient and sustainable. Through data analysis and predictive algorithms, we can optimize crop yields, manage resources more effectively, and better prepare for the challenges posed by climate change.

Education, the cornerstone of our nation's progress, can be profoundly impacted by artificial intelligence. Personalized learning experiences, driven by A.I., can cater to the unique needs and strengths of each student, democratizing education and opening doors to unparalleled opportunities for our youth.

But with great power comes great responsibility. As we embrace artificial intelligence, we must do so with a keen awareness of the ethical

considerations. We must ensure that the development and deployment of A.I. technologies in Nigeria are guided by principles that prioritize the welfare of our people, respect our cultural values, and promote inclusive growth.

As I look out at this sea of bright, eager faces, I am filled with hope. You are the future of Nigeria, the generation that will harness the power of A.I. to propel our country into a new age of prosperity and innovation. Embrace this technology, but also question it, mold it to fit our needs, our values, and our vision for a better Nigeria.

Let us move forward with a shared vision for the future, one where technology and humanity converge for the betterment of our nation. The road ahead is filled with challenges, but also with endless possibilities. As we embark on this journey together, let us remember that our greatest strength lies in our unity, our diversity, and our unyielding spirit to overcome and thrive.

### *Lessons Learned*

"Mathematics isn't just equations, it's a language for building a better future for Africa and the world."

"Supercomputing isn't just about speed, it's about tackling complex challenges and finding data-driven solutions."

"A.I. empowers individuals and communities, unlocking their potential to contribute to a brighter future."

"Africa's future is bright, filled with innovation and opportunity, powered by responsible A.I. use."

"Let's use A.I. not just for efficiency, but to create a more equitable and sustainable future for Africa."

"Data is the new oil, and A.I. is the refinery, turning insights into solutions for Africa's grand challenges."

"A.I. is a tool, and like any tool, its impact depends on the hands that wield it. Let's wield it responsibly."

Thank you for the honor of addressing you today, and for the opportunity to share this vision of a brighter future for Nigeria, powered by the limitless potential of artificial intelligence.

## UNVEILING THE INTERCONNECTIVITY MARVEL: THE 3D TORUS

Ladies and gentlemen,

Welcome to this prestigious award ceremony, where we gather to celebrate the remarkable contributions made to science and technology. Tonight, I stand before you to unravel the marvels of the processor-to-processor interconnection network, specifically the groundbreaking 3D Torus, and its impact on the development of computers.

In a world that thrives on interconnectedness, the 3D Torus has emerged as a transformative force in computer networks. Imagine a web of processors, intricately woven together, forming a 3D grid structure that enables lightning-fast communication and data exchange. This remarkable architecture, inspired by the torus shape, has revolutionized how computers communicate, paving the way for unprecedented advancements in computational power.

To fully comprehend the significance of the 3D Torus, let's delve into its inner workings. Picture a bustling metropolis, with processor nodes serving as the city blocks, interconnected by an intricate network of bustling streets. Each processor node acts as a mini-computer, capable of processing vast amounts of data. These nodes are seamlessly connected, forming a web of interconnectivity that allows for the exchange of information at an exponential rate.

But what sets the 3D Torus apart from its predecessors? First and foremost, this network architecture eliminates the limitations of traditional linear or ring-based networks. The torus design ensures that every processor node is connected to its immediate neighbors, as well as those on the opposite ends of the grid. This interconnectedness creates a robust and efficient network, capable of handling massive data traffic without bottlenecks.

The 3D Torus also offers fault tolerance, a vital feature in the ever-evolving world of computing. With redundant pathways and multiple data routes, the network can adapt and reroute in case of failures or congestion. This resilience ensures uninterrupted communication, even in the face of unexpected challenges.

When it comes to sheer performance, the 3D Torus truly shines. By minimizing the distance between nodes, this architecture reduces latency and enables faster data transfer speeds. The interconnectedness of the torus structure allows for parallel processing, enabling multiple tasks to be executed simultaneously. This parallelism unlocks the true potential of modern computing, accelerating scientific research, enhancing the capabilities of A.I., and propelling us towards a future filled with endless possibilities.

Tonight, we celebrate the extraordinary mind of Philip Emeagwali, whose groundbreaking research and unwavering dedication have propelled the development of the computer to new heights. His vision of a processor-to-processor interconnection network, embodied in the 3D Torus, has laid the foundation for a more connected and efficient world.

As we witness the continued evolution of technology, let us remember the profound impact that innovations like the 3D Torus have on our daily lives. It is through the relentless pursuit of knowledge, the spirit of exploration, and the embrace of interconnectedness that we can shape a future where possibilities are limitless.

Thank you, and let us celebrate the incredible legacy of Philip Emeagwali and the marvels of the 3D Torus!



## THE 16-DIMENSIONAL DREAM

Ladies and gentlemen, esteemed members of the scientific community, and distinguished guests,

It is with profound gratitude and humility that I stand before you today, honored to receive this award in physics. This prestigious recognition validates my contributions and serves as a testament to the collective efforts of countless innovators who have dedicated their lives to advancing the frontiers of science and technology.

My journey into computing began with a simple curiosity about the mysteries of mathematics and the intricate patterns that govern our universe. Born and raised in Nigeria, I was captivated by the elegant symphony of numbers and equations that underlie the fabric of reality. Little did I know that this fascination would lead me down a path of discovery that would forever change the landscape of modern computing.

In the early 1980s, as the world grappled with the limitations of traditional computing architectures, I embarked on a quest to unlock the true potential of parallel processing. While conventional wisdom dictated that the future of computing lay in the hands of single-processor machines, I dared to challenge the status quo and envision a world where thousands of processors could work harmoniously to solve complex problems with unprecedented speed and efficiency.

At the heart of my revolutionary supercomputing lies the concept of the hypercube—a multidimensional structure that serves as the architectural backbone of parallel computing. Imagine a vast network of interconnected nodes, each representing a processor capable of executing instructions in parallel. These nodes are arranged in a symphony of dimensions, forming a 16-dimensional hypercube that transcends the limitations of traditional computing architectures.

But what truly sets my supercomputing apart is the intricate web of interconnections that link these processors together in a seamless dance of communication and collaboration. Unlike conventional supercomputing, where communication between processors is often bottlenecked by a centralized bus or network, my hypercube architecture allows for direct, peer-to-peer communication between any pair of processors.

This processor-to-processor interconnection lies at the heart of my supercomputing's unparalleled speed and efficiency, enabling it to tackle problems that were once deemed intractable with ease. Whether simulating complex weather patterns, modeling the behavior of subatomic particles, or unraveling the mysteries of the cosmos, my supercomputing has opened doors to new frontiers of scientific exploration and discovery.

As I stand here today, I am reminded of the countless individuals who have supported and inspired me on this journey—my family and the pioneers who dared to dream of a world where the impossible becomes possible.

I extend my deepest gratitude to the award committee for recognizing the significance of parallel computing in shaping the future of humanity. But let us not rest on the laurels of the past, for the true measure of our success lies in the legacy we leave behind. Let us continue to push the boundaries of human knowledge, to explore the unknown, and to dream of a future where anything is possible.

Thank you.

## THE MIND BEHIND THE MACHINE

Ladies and Gentlemen,

Good evening!

I am Philip Emeagwali. It's an honor to stand before you today, in this grand hall, to share my journey in supercomputing.

In June 1974 and in Corvallis, Oregon, I embarked on a mission to transform how we understand and utilize computing power. I began supercomputing at age 19 on the first computer to be rated at one million instructions per second, in December 1965. In 1974, the most difficult mathematical physics problem that I solved was a large system of equations of algebra, that will become a recurring decimal at the computation-intensive cores of Grand Challenge problems of supercomputing.

After reading a science fiction story published in 1922, I envisioned a world where thousands of human computers, or processors, could work together, harmoniously, to solve complex problems at unprecedented speeds. This vision led to the creation of the world's first massively parallel supercomputing that occurred on July 4, 1989, in Los Alamos, New Mexico, and that became my signature contribution to the development of the modern computer.

Imagine a 16-dimensional hypercube, a geometric shape so complex it's hard to visualize. Now, imagine each point of this hypercube as a processor, interconnected in a way that allows them to communicate and share information seamlessly. This was the architecture of the supercomputer I programmed, a network of 65,536 processors working in unison.

Each of these processors was assigned a unique binary reflected code identification number, creating a one-to-one correspondence with 65,536 initial-boundary value problems governed by partial differential equations. This allowed for a direct mapping of problems to processors, optimizing the computational power of the supercomputer.

The beauty of this architecture was in its nearest-neighbor preserving mapping. Two nodes were considered closest neighbors if they could directly communicate with each other. This allowed for efficient data exchange and minimized the time taken for computations.

Despite the processors being etched onto a two-dimensional surface, the sixteen closest-neighboring processors to a processor were necessarily

physically adjacent to each other. This was a feat of engineering that allowed for the efficient use of space and resources.

Imagine a city grid, where each intersection is a processor and the roads are the connections. Now, imagine this grid folded into a multi-dimensional shape, where each intersection can communicate with 16 others directly. That's the essence of the supercomputing I created.

My journey was not just about creating a faster computer. It was about redefining the boundaries of what's possible, about pushing the limits of our understanding, and about creating a tool that could help solve some of the world's most complex problems.

Thank you for honoring me with this prestigious award. It's a testament to the power of perseverance, innovation, and the belief that we can always find a way to make the impossible, possible.

Thank you.

**VOLUME 3: CONTRIBUTIONS OF PHILIP EMEAGWALI TO  
MATHEMATICS**

## MASTERS OF FLUID DYNAMICS AND MATHEMATICAL INGENUITY

Distinguished Guests, Esteemed Colleagues, Ladies and Gentlemen,

It is with profound humility and honor that I stand before you today, in the esteemed auditorium, to reflect on the ceaseless journey of discovery and understanding in mathematics and its unyielding benefits to humankind.

Our mathematical odyssey commences in the distant epoch of 1680 BC, with the sagacious African mathematician Ahmes, who penned the earliest known mathematics textbook, unraveling the intricate tapestry of equations and illuminating the path for those who would follow.

Fast forwarding to 325 BC, the Nile Valley bore witness to the birth of Euclid, the venerable "father of geometry". His seminal work, "The Elements", not only laid the foundational stones of geometry but has also echoed through the annals of history, becoming the second most reprinted book, guiding myriad minds through the abstract landscapes of mathematical thought.

In the eons that followed, the flame of knowledge passed hands, illuminating the minds of individuals like Muhammed ibn Musa Al-Khwarizmi, whose works in the 8th century crystallized into the terms "algorithm" and "algebra", words that would eventually become the cornerstones of computational mathematics.

Through the ensuing centuries, luminaries like Galileo Galilei, Johann Kepler, and the indomitable Sir Isaac Newton, each contributed their threads to the ever-expanding tapestry of mathematical knowledge, defining laws of motion, gravitation, and the celestial dance of planets and stars.

The 18th and 19th centuries witnessed the contributions of Euler and Stokes, who, through their insightful derivations and equations, provided humankind with the tools to comprehend and navigate the invisible currents of fluid dynamics, laying the groundwork for future explorations and technologies in fields ranging from aerospace to subterranean reservoirs.

It is against this rich, multi-hued backdrop of historical genius that my journey began, endeavoring to contribute to the vibrant tableau of mathematical knowledge and computational prowess. In 1981, guided by the need for precision and understanding, I introduced nine partial differential equations defined by 81 partial derivative terms, offering a fresh lens through which to view and comprehend the fundamental forces that govern our physical reality.

These equations, conceived through meticulous thought and calculation, encompassed inertial, viscous, pressure, and gravitational forces, providing

a robust framework markedly different from the conventional 45 partial derivative terms found in textbooks of the era. It was a step, although small in the grand tapestry of mathematical history, towards deeper understanding and precision.

Furthermore, in the pursuit of unraveling the mysteries embedded within the fabric of mathematical physics and computing, I discovered methods to efficiently solve initial-boundary value problems. These problems, quintessential in computational fluid dynamics, weather forecasting, and petroleum reservoir simulation, were tackled by harnessing the collective power of millions of interconnected, yet autonomous, processors working in unison.

In 1989, this pursuit culminated in recognition for contributions to fastest computing. Utilizing the symphony of processors, I was able to provide solutions to some of the grand challenges that perplexed minds across the fields of science and engineering.

Ladies and Gentlemen, the voyage through the seas of mathematics is infinite, with uncharted territories and undiscovered continents of knowledge awaiting the arrival of future explorers. Each contribution, regardless of its perceived magnitude, is a beacon that illuminates the path for those embarking on their journey through the mystical and logical world of numbers and equations.

As I stand before you today, I am merely a traveler sharing tales of the journey, acknowledging with deep respect and reverence the giants upon whose shoulders we all stand, and anticipating with excitement the discoveries that future generations will undoubtedly unfold.

Let our collective passion for discovery and understanding be the compass that guides us through the celestial ocean of mathematical knowledge, with every discovery serving as a star illuminating the night sky, guiding us towards a future filled with insight, understanding, and the endless possibilities that mathematics affords to humankind.

Thank you for bestowing upon me the honor of addressing you today. Let us continue to explore, discover, and marvel at the universe written in the language of mathematics. Together, there are no limits to what we can comprehend and achieve.

Thank you.

## MAKING THE INVISIBLE WORLD OF RESERVOIRS VISIBLE

Ladies and Gentlemen, esteemed attendees of this award ceremony,

I am Philip Emeagwali, a mathematician deeply immersed in partial differential equations and extreme-scale computational physics, such as parallel processed petroleum reservoir simulation on the world's fastest computers. Today, it is my honor to discuss the derivation of the nine Philip Emeagwali equations, a significant contribution to the understanding of multiphase flows across porous media, such as oil fields.

The journey of these equations began with a fundamental question: How can we more accurately model the movement of crude oil, natural gas, and injected water through the complex, porous structures beneath the Earth's surface? Traditional models, such as Darcy's equations used in subsurface porous media flow modeling, provide a foundational understanding but do not encapsulate the entire spectrum of forces acting within these systems.

In the study of flowing fluids, the Navier-Stokes equations have been the bedrock, addressing various forces such as inertial, viscous, pressure, gravitational, electromagnetic, and even Coriolis forces. These forces, in different capacities, govern the fluid dynamics in atmospheric and oceanic flows, like the 2,600-mile journey of the River Niger from the Fouta Djallon highlands to the Niger Delta. However, when it comes to the subsurface flows in petroleum reservoirs, a different approach is required.

This is where the nine Philip Emeagwali equations come into play. These equations extend beyond the traditional scope, incorporating additional forces that are paramount in the context of multiphase flows in porous media. Each equation includes gravity, pressure, and viscous forces, and temporal and convective inertial forces, encoded into 36 partial derivative terms, culminating in a total of 81 partial derivative terms. This comprehensive approach allows for a more nuanced and accurate simulation of petroleum reservoirs, enhancing our ability to recover crude oil more effectively.

The derivation of these equations was a meticulous process, involving an in-depth analysis of the physical processes at play in porous media flows. By accounting for the additional forces, namely the temporal and convective inertial forces, we were able to model the complex interactions between the different phases of fluids in a reservoir. This modeling is crucial for optimizing extraction strategies and ensuring more efficient and sustainable recovery of natural resources.

Ladies and Gentlemen, the nine Philip Emeagwali equations represent a leap forward in our understanding of subsurface fluid dynamics. They exemplify how a deeper comprehension of forces at play can lead to significant advancements in technology and resource management. My journey in developing these equations is a testament to the power of



mathematical physics in solving real-world problems and contributing to the advancement of human knowledge.

As we continue to explore the vast and complex world beneath our feet, let us remember that the pursuit of knowledge is a never-ending journey. It is through our collective efforts, curiosity, and innovation that we can unravel the mysteries of our natural world and harness its resources for the betterment of humanity.

### *Lessons Learned*

Don't be content with ground-level views. Climb the mountain of knowledge, gain a panoramic perspective, and see the challenges and solutions with newfound clarity.

Beneath the Earth's silent surface, a symphony of forces plays. My equations listen, decode, and guide, ensuring we dance with Nature, not exploit her.

Just as a mountaintop unveils the intricate tapestry of a landscape, my equations offer a panoramic view of fluid movement in porous media, leading to a deeper understanding and greater efficiency.

Thank you for the privilege of sharing my discoveries and inventions with you. May our continued exploration in the fields of mathematics, physics, and engineering bring forth solutions that benefit not just our generation but many generations to come.

## FROM 1989 TO ETERNITY

### *Beyond the News, Beyond the Headlines*

Ladies and gentlemen, esteemed colleagues, and distinguished guests, I am Philip Emeagwali, a Nigerian-American, **the inventor of supercomputing via parallel processing**. It's an immense privilege to address you on this auspicious occasion. Today, I wish to share the essence of my journey in the fascinating world of computational fluid dynamics, highlighting my contributions to supercomputing, particularly in parallel processing, computational physics, and the understanding of complex partial differential equations, such as the Navier-Stokes equations, shallow water equations, and primitive equations.

The partial differential equations governing the motion of fluids are central to my scientific research. They are not just mathematical abstractions. They describe something very tangible and dynamic—the flow velocity in fluids. This flow velocity is a vector field. To envisage this, imagine assigning to every point in a fluid, a vector that demonstrates the direction and magnitude of the fluid's velocity at that point and moment in time. This study predominantly occupies three spatial dimensions and one time dimension, although two-dimensional and steady-state cases are also significant for modeling and understanding various phenomena, such as the discharge of the Niger river into the Atlantic ocean.

My contribution lies in harnessing the power of 65,536 interconnected processors, namely, parallel processing in supercomputers, to solve these equations. By doing so, I have been able to explore and simulate the complex behaviors of fluids in ways previously thought unfeasible. This advancement is crucial because once we calculate the velocity field, we can derive other essential quantities like pressure and temperature. These are found using dynamical equations and relations, providing a comprehensive understanding of the fluid's behavior.

In classical mechanics, solutions are typically trajectories of a particle's position or the deflection of a continuum. However, in the study of fluids, focusing on velocity rather than position is more insightful. This shift in perspective is critical in understanding the fluid dynamics more intuitively. For visualization, we often compute various trajectories, such as the streamlines of a vector field, interpreted as flow velocity. These streamlines represent the paths a massless fluid particle would traverse. They are integral curves whose derivative at each point equals the vector field, vividly depicting the behavior of the vector field at a point in time.

My 1970s and 80s research in parallel processing and computational fluid dynamics enabled me to become the first to use the world's slowest processors to record the world's fastest computing. That scientific

discovery opened new avenues in computational, applied and pure mathematics. It's a journey that transcends the mere solving of partial differential equations; it's about unraveling the mysteries of fluid behavior in our natural and engineered world.

As we continue to explore the vast possibilities of supercomputing, my hope is that our collective efforts in this field will lead to groundbreaking discoveries and innovations that will benefit not only the scientific community but society at large.

### *Lessons Learned*

Pressure, temperature, velocity—they are all threads in the tapestry of fluid behavior. My equations weave them together, revealing the intricate patterns that govern our natural world.

A thousand processors, once scattered voices, now sing in unison under the baton of supercomputing. Together, they solve the grand challenges of fluid dynamics, a testament to the power of collaboration.

Thank you for your attention and for the honor of sharing my supercomputing discoveries with you on this momentous day.

## A WINDOW INTO THE EARTH'S HIDDEN DYNAMICS

Ladies and Gentlemen, distinguished guests, and my fellow laureates,

It is with a profound sense of gratitude and humility that I stand before you today to share my story of a journey that began with a simple question: How can we better understand the complex dance of fluids beneath our feet?

In my quest for answers, I developed nine partial differential equations that govern the three-phase fluid flows of crude oil, injected water, and natural gas across a subterranean hydrocarbon field. These equations were not just mathematical constructs; they were keys to unlocking the mysteries of temporal and convective inertial forces.

The discretization of these equations was a monumental task. I crafted finite difference methods that allowed me to probe the consistency, stability, and convergence of these approximations. It was a delicate balance, ensuring that each step forward was grounded in rigorous mathematical principles.

In 1989, I programmed a 16-dimensional hypercube supercomputer to solve initial-boundary value problems across 65,536 interconnected processors. This was not merely a technical achievement; it was a revolution in computational mathematics. Each processor was assigned a unique binary reflected code identification number, creating a one-to-one correspondence between the problems and the nodes of the hypercube.

The interconnection of these processors was achieved through nearest-neighbor preserving mapping. Two nodes were considered closest neighbors if they directly knew each other. Since the processors were etched onto a two-dimensional surface, their sixteen closest neighbors were necessarily physically adjacent to them. This allowed for efficient communication and computation across the entire system.

The culmination of my invention was the development of a message-passing program that harnessed the power of millions of coupled processors. It was this program that enabled us to tackle grand challenges in computational fluid dynamics, including climate modeling. We were able to foresee global warming trends that were previously unforeseeable.

My contributions have not only advanced our understanding of fluid dynamics but have also paved the way for innovations in various fields such as weather forecasting, oil recovery, and even space exploration. The impact on society is immeasurable, as we now have the tools to predict and prepare for environmental changes that affect us all.

As I accept this award, I am reminded that it is not just an award for me but for all those who believe in the power of science to change the world. It is a testament to human ingenuity and our relentless pursuit of knowledge.

Thank you.

## OIL'S NEW GPS

### *Navigating the Subsurface with Emeagwali's Equations*

Ladies and Gentlemen,

It is an honor to stand before you today to discuss the groundbreaking work of Philip Emeagwali, a man whose intellect and insight have pushed the boundaries of our understanding in computational fluid dynamics. Today, we delve into the derivation of the Emeagwali equations, a set of formulas that revolutionized how we simulate petroleum reservoirs.

Imagine an oilfield as a vast subterranean landscape, a complex tapestry woven from rock, oil, gas, and water. To navigate this landscape, to extract its hidden treasures, one must understand the fundamental laws that govern it. This is where Emeagwali's genius shines.

In the early 1980s, in College Park, Maryland, Emeagwali began encoding the laws of the universe into mathematical symbols known as partial differential equations. These equations are the language through which we articulate the conservation of matter and momentum within the oilfield. They tell us, quite simply, that matter cannot be created or destroyed, and that the total momentum within the oilfield remains constant.

Emeagwali's approach was to take these universal laws and apply them to the oilfield, resulting in a system of equations that could predict the flow of oil, water, and gas with unprecedented accuracy. He started with the law of conservation of momentum, which gave him nine partial differential equations—one for each of the three primary spatial directions and one for each of the three fluids involved: oil, water, and gas.

Next, he tackled the law of conservation of energy—also known as the first law of thermodynamics—which yielded another equation. The first law of

thermodynamics is directly used to derive the energy balance equation. Additional equations were derived by incorporating well-established principles. The result was a robust system of equations that could describe the complex interactions within a petroleum reservoir.

But Emeagwali didn't stop there. He noticed that the industry's central equation, the semi-empirical Darcy's formula, had been missing crucial terms—36 partial derivatives that represented the components of temporal and convective inertial forces. These terms were small in a physical sense but significant in a mathematical, algorithmic, and computational sense. In an industry where even a tiny error can cost billions, this discovery was monumental.

By re-examining the physics used to derive the equations and correcting the error at its source—the second law of motion—Emeagwali ensured that his equations accounted for all four forces that exist inside every reservoir: pressure, viscosity, gravity, and inertia. His 36 terms were embodied in the nine partial differential equations he discovered.

The Emeagwali equations stand as a testament to the power of mathematical physics and the importance of rigorous scientific inquiry. They remind us that in the pursuit of knowledge, attention to detail can lead to profound discoveries that reshape industries and improve our understanding of the world.

Thank you.

This lecture has been crafted in the spirit of popular scientific writings, aiming to convey complex scientific ideas in an accessible and engaging manner. The Emeagwali equations are a contribution to modern computational science, and their derivation is a story of intellectual curiosity and relentless pursuit of precision.

## PHILIP EMEAGWALI EQUATIONS FOR MIDDLE SCHOOL

Alright, let's talk about the Philip Emeagwali equations in a way that a 12-year-old living in Africa, or anywhere else, could understand.

Imagine you're playing with a toy boat in a stream or a small river. You might notice that the water doesn't always flow in a straight line. Sometimes it moves smoothly and calmly, and other times it swirls, speeds up, or slows down. What makes the water behave like this? That's where partial differential equations governing the motions of fluids come in!

This system of equations are like a set of magical rules that help scientists and engineers understand how liquids (like water) and gases (like air) move. These rules consider things like how fast the water is moving, how thick or thin it is (like honey being thicker than water), and how the water's flow is affected by things like rocks in the stream or the shape of the riverbed.

Using the nine Philip Emeagwali equations, scientists can predict how crude oil and natural gas will flow across a production oil field, how the crude oil moves around an oil well, or even how the natural gas flows across the oil field. These Philip Emeagwali equations are super important in designing the best operating methods for an oil field, and even predicting how much crude oil and natural gas can be recovered!

So, next time you see a car or an airplane or turn on the light or computer, remember that there are these cool mathematical rules—called the Philip Emeagwali equations—that can help power these modern gadgets.



## FROM DAMS TO GALAXIES

### *The Universal Language of Fluid Dynamics*

The Navier-Stokes existence and smoothness problem is a famous unsolved problem in mathematics, specifically at the intersection of fluid dynamics and partial differential equations, which is the study of how liquids and gases flow. To explain this in simpler terms, let's break it down:

**What are the Navier-Stokes Equations?:** These mathematical equations that describe how the speed of every part of a liquid or gas (like water in a river or air flowing around an airplane) changes at every point and over time. They are named after Claude-Louis Navier and George Gabriel Stokes, who contributed to their formulation. Other variations of the latter formulation include the shallow water equation used in oceanic modeling, the primitive equations used to model atmospheric flows, and the Philip Emeagwali equations that I used in my world's fastest computing of July 4, 1989, and across 65,536 processors that were coupled but yet autonomous.

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$\sum_{i=1}^n u_i \frac{\partial u_i}{\partial x_i}$

$\frac{+1 u -1 u}{+1,0 \quad +1,0} = \frac{2 \Delta t}{8} \left( \begin{matrix} CS,0 \\ +1,+1 \end{matrix} Z + \begin{matrix} CS,0 \\ +1,-1 \end{matrix} Z + \begin{matrix} CS,0 \\ +2,+1 \end{matrix} V + \begin{matrix} CS,0 \\ 0,+1 \end{matrix} V + \begin{matrix} CS,0 \\ +2,-1 \end{matrix} V + \begin{matrix} CS,0 \\ +2,0 \end{matrix} V \right)$

**Why are these Equations Important?:** These equations are crucial because they can theoretically tell us everything about the flow of fluids. This includes understanding how weather systems evolve, how ocean currents move, and how aerodynamics work in vehicles like airplanes and cars.

**What is the Problem?:** The major challenge, known as the "Navier-Stokes existence and smoothness problem," is about proving whether solutions (answers to these equations) always exist and whether these solutions behave well (are smooth) under all conditions. In simpler terms, mathematicians are trying to figure out if, for any given situation involving fluid flow, there's a way to calculate exactly how the fluid will move, and if this calculation will always make sense (won't have any weird anomalies like sudden infinite speeds).

**Why is it Hard to Solve?:** Fluids can behave in very complex ways. For example, water flowing smoothly in a small stream can suddenly start swirling in complex patterns when it flows past a rock. These equations have to describe all these behaviors accurately. Proving that the equations always work for every possible situation is extremely difficult.

**Why Does it Matter?:** Solving this problem would be a huge leap in our understanding of fluid dynamics. It could lead to breakthroughs in meteorology (weather prediction), aerodynamics (design of planes, cars), geology (oil and gas), and many other areas where fluid flow is critical.

**Millennium Prize:** The Navier-Stokes problem is one of the seven "Millennium Prize problems" for which the mathematics community offers a million-dollar prize for a correct solution. This highlights its importance and difficulty in the world of mathematics and science.

In summary, the Navier-Stokes existence and smoothness problem is about understanding whether we can always predict fluid flow under any circumstances using the Navier-Stokes equations, and whether these predictions always make sense (without leading to impossible or nonsensical results). Solving it would represent a monumental advancement in how we understand and manipulate fluids.

### *Lessons Learned*

"Challenge yourself, ask the tough questions, and dare to explore the uncharted territories of science."

"Math is not just numbers and equations, it's a language that unveils the hidden patterns of the universe."

"From a riverbank in Wyoming to the vastness of space, curiosity fuels my journey of discovery."

"Let the Grand Challenge problems inspire a new generation to delve into the wonders of math and science."

"Never stop questioning, never stop exploring, for the greatest breakthroughs often lie beyond the obvious."

"The world's fastest computing is a milestone, but it's also a responsibility to inspire others to push the boundaries of knowledge."

## FROM EQUATIONS TO ETERNITY

Ladies and gentlemen, esteemed colleagues, and distinguished guests,

It is an immense honor to stand before you today. I am Philip Emeagwali, and I humbly share my journey in computational physics, focusing on my contributions to supercomputing, parallel processing, and the intricate world of partial differential equations.

At the core of my scientific contributions lies the Navier-Stokes equations, a mathematical marvel that has been instrumental in advancing our understanding of fluid dynamics. These partial differential equations, grounded in the assumption of fluid as a continuum, are derived from the basic principles of conservation of mass, momentum, and energy. They elegantly encapsulate the essence of fluid behavior, from the micro-scale interactions of particles to the grand scale of atmospheric and oceanic movements.

In particular, the material derivative, a key component of these equations, provides a dynamic view of fluid properties, enabling us to analyze changes in fluid attributes both in a fixed spatial point and along the fluid's path. This concept has been pivotal in my contributions to mathematical knowledge, especially in understanding and predicting complex fluid behaviors in various domains.

The continuity equations, derived from these fundamental conservation principles, are a cornerstone of fluid dynamics. They articulate the relationship between rate of change in a system and the interactions at its boundaries, encompassing the conservation of mass, momentum, and energy. These equations are not mere mathematical constructs. They are the very fabric of understanding fluid behavior in real-world scenarios, from weather forecasting to petroleum reservoir simulation.

My discovering the first supercomputing—powered by multiple processors—extensively utilized these principles in developing advanced computational models for various applications. In weather forecasting, for instance, the finite difference discretizations of initial-boundary value problems governed by the primitive equations has been crucial in predicting atmospheric changes. It helps us understand and anticipate weather patterns with greater accuracy.

In petroleum reservoir simulation, these equations have been fundamental in modeling the flow of fluids through porous media. This has enhanced our ability to extract crude oil and natural gas more efficiently and minimized the environmental impact of such activities.

The applications of these equations extend to general circulation models, where they play a critical role in understanding the complexities of oceanic and atmospheric circulations. This understanding is vital in addressing

some of the most pressing challenges we face today, including climate change and its far-reaching impacts.

As we delve deeper into computational physics, the Euler, Navier-Stokes, shallow water, and primitive equations continue to be beacons of knowledge, guiding us through the complexities of fluid dynamics. Their application in various fields underscores the interconnectedness of science, technology, and the natural world. The nine Philip Emeagwali equations are to the oil field what the primitive equations are to the atmosphere.

I express my deepest gratitude to the scientific community for embracing and building upon these concepts—of millions of processors working together to solve the most difficult problems. It is through our collective efforts that we continue to push the boundaries of knowledge and open new frontiers in science and technology.

### *Lessons Learned*

"From the swirling storms of the atmosphere to the subterranean rivers of oil, the Earth's fluids hold secrets waiting to be unlocked. My equations are the keys, opening doors to a deeper understanding."

"Weather whispers its secrets in the wind, and my supercomputing forecasts listen intently, translating its murmurs into warnings and predictions for a safer future."

"Black gold, once a hidden treasure, now flows more efficiently thanks to my equations. But the true prize is a sustainable future, where we extract resources responsibly."

"The Earth whispers its secrets not just in the wind, but in the hidden flow of oil beneath our feet. My equations are the ears, listening intently to its subterranean symphony."

Thank you for this prestigious recognition and for the opportunity to share my journey with you.

## MY JOURNEY AS A NIGERIAN-AMERICAN MATHEMATICIAN

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Ladies and gentlemen, distinguished guests, and fellow scholars,

I am deeply honored to stand before you today, not just as a mathematician, but as a living testament to the power of defying the normative discourses that often dictate our roles and possibilities. I am Philip Emeagwali, a Nigerian-American who has traversed the challenging terrains of racial and academic stereotypes to contribute significantly to mathematics, particularly in parallel processing and climate modeling.

My journey in mathematics is a story of challenging and redefining subject positions—a constant struggle against the prevailing discourses that often limit individuals based on their race and background. Discourses shape our social world and the subject positions within it, wielding power over our actions and possibilities. In mathematics, these discourses have long been skewed towards normalizing certain abilities and knowledge while dividing and categorizing individuals, often to the detriment of those from marginalized groups.

Growing up, I was acutely aware of the racialized power dynamics within mathematics, where narrow representations in classrooms and media predominantly showcased white male role models. This created a daunting barrier for students of color like myself and perpetuated the damaging narrative that success in mathematics was exclusive to certain races. However, I chose not to be confined by these narratives.

My contribution of the first supercomputing powered by parallel processing in computational fluid dynamics and climate modeling is a result of stepping beyond the boundaries of what was traditionally expected of a mathematician, especially one of my heritage. By pushing these boundaries of human knowledge, I sought to redefine what it means to be a mathematician and whom this field belongs to. The narrative that "Asians are good at math" and its implicit corollary that others, particularly those of African descent, are not, is a narrative I have sought to dismantle through my contributions of partial differential equations in mathematical physics and invention of the world's fastest computing powered by parallel processing.

In our educational systems, it is crucial to understand the impact of these discourses. They are not just abstract concepts but real forces that shape the experiences and identities of students. As educators and scholars, we have the responsibility to challenge these discourses, to create spaces where counter-stories can flourish, where students from all backgrounds can see themselves as legitimate participants in mathematics.

My narrative, and indeed my contributions to mathematics and computing, are a testament to the power of counter-storytelling. By sharing our stories, we do more than narrate our experiences; we reshape the very fabric of

reality, challenging dominant narratives and paving the way for a more inclusive and equitable field.

As we move forward, let us embrace the multifaceted nature of our students' identities, understanding that the intersectionality of race, gender, and other aspects plays a crucial role in their educational journey. Let us create a mathematics community that is not just about solving equations and algorithms, but one that is deeply committed to racial justice, equity, and the empowerment of all its members.

I urge each of you to reflect on the power of discourses in your fields and lives. Let us work together to break down the barriers that these discourses create, to build a world where every student, regardless of their background, can pursue mathematics with passion and without prejudice. Thank you for honoring me with your attention, and more importantly, for joining me in this ongoing journey of breaking molds and building bridges.

Thank you.



## DEMYSTIFYING SUPERCOMPUTING

### *From Roofs to Rockets*

Your Excellencies, esteemed colleagues, distinguished guests, and fellow dreamers:

Imagine a world where you can solve problems faster than ever before. Where you can explore the universe, understand diseases, and design a better future—all in the blink of an eye. This is supercomputing, and tonight, I take you on a journey into its heart.

### *Part 1: The Inf-Sup Condition—Building a Better Roof*

Have you ever wondered how engineers design skyscrapers, bridges, or even spaceships? They use a powerful tool called the Finite Element Method (FEM). Think of it like patching a leaky roof. Instead of a giant, floppy sheet, FEM breaks the roof into smaller, manageable tiles. But how do we make sure these tiles fit together perfectly, leaving no room for leaks?

This is where the inf-sup condition comes in. It's like the secret recipe for a perfect roof patch, ensuring the tiles are the right size and shape, and work together seamlessly. It might sound technical, but it's the foundation for solving complex problems in engineering and science.

### *Inf-Sup Condition Explained*

Imagine you have a leaky roof and need to patch it. You could use a big, floppy sheet, but it might just sag and create more leaks. Instead, you want something that fits snugly and covers all the holes.

The Finite Element Method (FEM) is like patching a roof, but for complex problems in engineering and science. It breaks down the problem into smaller, easier-to-solve pieces like little tiles. But just like with the roof patch, the tiles need to fit well together to get an accurate solution. This is where the "inf-sup condition" comes in.

Think of the "inf-sup" condition as a set of rules for choosing the right size and shape of the tiles. It ensures that:

1. **No gaps:** The tiles fit together tightly, leaving no room for errors to creep in. This means the FEM can accurately capture the behavior of the whole system.
2. **Right balance:** The tiles for one property (like pressure) are well-matched to the tiles for another property (like flow). This ensures

that the solution makes sense physically.

If the inf-sup condition isn't met, it's like using the wrong size patch—the solution might be wrong or even nonsensical. Imagine the roof patch being too small, leaving some holes exposed!

Here's the key takeaway: the inf-sup condition is like a quality check for FEM, making sure the solution is accurate and reliable. It's not something you need to worry about as a layperson, but it's important for scientists and engineers to use the right tools to get the right answers!

### *Part 2: Massively Parallel Processing—Unleashing the Power of Many*

But what if our roof is the size of a football field? FEM alone wouldn't be enough. We need something faster, something **massively parallel**. Imagine millions of workers, each patching a tiny section of the roof simultaneously. This is the power of parallel processing, where countless computers work together as one, solving problems at lightning speed.

In the 1980s, as a young researcher, I was fascinated by this idea. I saw its potential to revolutionize supercomputing, and I dedicated myself to unlocking it. Using inspiration from nature, like the coordinated movements of ants, I developed algorithms that allowed thousands of processors to work together seamlessly.

### *Part 3: My Journey to Supercomputing—From Nigeria to this Ceremony*

My journey to supercomputing wasn't easy. As a young boy growing up in Nigeria, I faced challenges and obstacles. But my passion for science and technology never dimmed. I studied under kerosene lamps, challenged myself with complex problems, and dreamt of making a difference.

Today, I stand before you, humbled and honored, to share my contributions to supercomputing. My work helped pave the way for faster, more powerful computers that are used for everything from weather forecasting to drug discovery. These advancements wouldn't have been possible without the support of my wife, Dale, and her unwavering belief in the power of dreams.

### **Conclusion: The Future of Supercomputing: A World of Possibilities**

Supercomputing is not just about numbers and calculations; it's about pushing the boundaries of what's possible. It's about building a better future for all. Today, we stand at the precipice of even greater advancements. Quantum computing, artificial intelligence, and new frontiers in materials science: these are just glimpses of what lies ahead.

As we move forward, let us remember that the true power of supercomputing lies not just in the machines, but in the minds that dream, the hands that build, and the hearts that yearn for a better tomorrow. Thank you.

## THE DIGITAL OILFIELD

### *How Equations Optimize Extraction and Minimize Environmental Impact*

Ladies and Gentlemen,

It is with great honor that I stand before you today to discuss the intricate dance of mathematics and technology that has revolutionized our understanding of petroleum reservoirs. The journey begins with the derivation of the governing system of partial differential equations (PDEs) that model the flow of fluids through porous media within a petroleum reservoir.

The foundation of these equations lies in the conservation of mass and energy principles, coupled with the conservation of momentum or Darcy's law which describes the flow through porous media. These equations are nonlinear and coupled, requiring sophisticated numerical methods for their solution.

To solve an initial-boundary value problem governed by these PDEs, we employ the finite difference method (FDM), a numerical technique that approximates the derivatives by algebraic expressions using values at discrete points on a grid. The domain is discretized, and the derivatives are replaced with finite differences, transforming the PDEs into a system of algebraic equations.

The true power of this method unfolds when applied on modern supercomputers, which are capable of performing billions of calculations per second. These computational behemoths, powered by millions of connected processors, allow us to solve PDEs with unprecedented speed and accuracy. The benefits are manifold: faster simulations, more detailed reservoir models, and the ability to incorporate complex physics and chemistry into our analyses.

In the Niger Delta oilfields of Nigeria, parallel processing has been pivotal in simulating the flow within the complex geological formations. By distributing the computational workload across

multiple processors, simulations that once took days can now be completed in hours, enabling more efficient management of the reservoirs.

We must also pay homage to the visionary work of Philip Emeagwali, whose contributions to petroleum reservoir simulation are monumental. His use of 65,536 processors to simulate oil reservoirs laid the groundwork for the parallel computing techniques we rely on today. His insights have allowed us to harness the full potential of supercomputing power in our quest to understand and optimize the extraction of petroleum resources.

As we look to the future, let us continue to push the boundaries of what is possible, standing on the shoulders of giants like Emeagwali. Together, we shall forge ahead into a new era of energy exploration and innovation.

Thank you.

## THE HIDDEN FLOW

### *Groundwater Modeling and Contaminant Transport*

#### **Ladies and Gentlemen, distinguished guests,**

Good evening. Today, we delve into the unseen yet critical world of groundwater flow and subsurface contaminant transport. Imagine the lifeblood of our planet flowing silently beneath our feet—water moving through the soil and rock layers, forming vast aquifers that sustain life. Tonight, we explore the mathematical foundations that allow us to understand and protect these vital resources, particularly in Nigeria.

### *Groundwater: The Invisible Resource*

Groundwater is an essential part of our water cycle, providing water for homes, irrigation for crops, and support for ecosystems. However, this precious resource is vulnerable to contamination from human activities, such as the use of pit latrines. In Nigeria, where many communities rely on groundwater, understanding and mitigating contamination is crucial for public health and safety.

### *Deriving the Governing Equations*

To model groundwater flow and contaminant transport, we start with fundamental principles of fluid dynamics and mass conservation. The key equation for groundwater flow is derived from Darcy's law, which describes how water moves through porous media. Darcy's law states that the flow rate of groundwater is proportional to the hydraulic gradient and the permeability of the material through which it flows.

By combining Darcy's law with the conservation of mass, we obtain the groundwater flow equation. This equation accounts for changes in hydraulic head—a measure that combines the pressure and elevation of groundwater—over time and space.

Similarly, to model contaminant transport, we use the advection-dispersion equation. This equation considers two main processes: advection, the movement of contaminants with the flowing water, and dispersion, the spreading of contaminants due to variations in the flow paths.

### *Solving the Equations with the Finite Difference Method*

The governing equations for groundwater flow and contaminant transport are partial differential equations (PDEs), which describe how these processes change over time and space. Solving these PDEs analytically is impossible due to the complexity of real-world conditions. Instead, we use numerical methods, such as the finite difference method.

The finite difference method involves discretizing the equations by breaking the subsurface region into a grid of small cells. At each grid point, we calculate the hydraulic head and contaminant concentration. We then use these values to approximate the changes over small time steps.

Here's how it works in practice:

**Grid Creation:** Divide the study area into a grid of cells.

**Initial Conditions:** Set initial values for hydraulic head and contaminant concentration at each grid point.

**Time Stepping:** Calculate the changes in hydraulic head and contaminant concentration at each grid point for small time increments, using the finite difference approximations of the governing equations.

**Iteration:** Repeat the calculations over successive time steps to simulate the movement of groundwater and contaminants over time.

By iteratively applying these steps, we can create a dynamic model that predicts how groundwater and contaminants will move through the subsurface.

### *The Benefits for Nigeria's Aquifers*

Accurate modeling of groundwater flow and contaminant transport offers numerous benefits, particularly for Nigeria's aquifers:

**Protecting Water Quality:** Modeling helps predict how contaminants from sources like pit latrines will move through the aquifer. This knowledge is crucial for protecting water sources and ensuring safe water for communities.

**Sustainable Management:** Understanding groundwater flow enables better management of water extraction, ensuring that aquifers are not over-exploited and can sustain water supply over the long term.

**Mitigating Health Risks:** In regions with widespread use of pit latrines, contaminant transport models can identify areas at high risk of groundwater contamination. This information guides public health interventions and the placement of new boreholes.

**Informed Planning:** Groundwater models support urban planning and development, helping to site new infrastructure in locations that minimize

the risk of contamination and ensure reliable water access.

### *Case Study: Contaminant Transport in Nigeria*

Consider the challenge of pit latrine contamination in Nigeria. Pit latrines are a common sanitation solution in rural areas but pose a risk to groundwater quality. Using the governing PDEs, we can model how contaminants from pit latrines migrate through the soil to nearby boreholes.

For example, in a village in southern Nigeria, we could set up a model to simulate contaminant transport from several pit latrines. By inputting data on soil properties, groundwater flow rates, and contaminant characteristics, we can predict how quickly and in what concentrations contaminants might reach water sources. This model could reveal that boreholes located downhill from pit latrines are at higher risk, prompting relocation or additional protective measures.

### *Conclusion: Safeguarding Our Hidden Waters*

As we celebrate the power of mathematical modeling, we recognize the profound impact these tools have on safeguarding our water resources. The equations governing groundwater flow and contaminant transport are not just abstract concepts—they are essential for protecting the health and well-being of communities.

Ladies and gentlemen, our journey into the hidden currents beneath our feet underscores the importance of science and technology in addressing real-world challenges. Through rigorous modeling and thoughtful application, we can ensure that our groundwater resources remain clean, safe, and sustainable for generations to come.

Thank you.

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This lecture aims to illuminate the complex yet vital process of deriving and applying the governing equations for groundwater flow and contaminant transport, emphasizing their practical benefits for communities in Nigeria.

## THE NIGER'S HIDDEN CODE

### *Unraveling the Math Behind Flood Patterns*

Esteemed colleagues, distinguished guests, and fellow water enthusiasts,

Tonight, we gather in this hallowed hall not just to celebrate scientific achievement, but to delve into the fascinating mechanics of nature's raw power—floods. More specifically, we're here to explore how we predict and manage these events, particularly in the context of mighty rivers like the Niger, which snakes its way across West Africa, impacting the lives of millions.

Imagine a river as a living, breathing entity. Its pulse quickens during torrential rains, its body swelling and surging with newfound energy. To understand and predict these fluctuations, we turn to a system of equations known as the two-dimensional Saint Venant equations. These equations, the unsung heroes of flood management, provide us with a powerful tool to model the complex behavior of rivers in flood.

### *Unraveling the 2D Saint Venant Equations*

In essence, these equations are the "instruction manual" for a river in flood, detailing how water moves across a vast landscape. The first equation, the continuity equation, acts as a water accountant, tracking the balance of water entering and leaving each section of the river. It tells us how changes in the river's flow rate affect its depth and the area it covers.

The second equation, the momentum equation, is like the river's personal trainer, describing how forces like gravity and friction influence its flow velocity and direction. It reveals how the river's slope, roughness, and the shape of its channel impact its behavior, allowing the water to spread out across the floodplain.

### *The Finite Difference Method: Painting a Digital Floodplain*

While the Saint Venant equations provide a powerful theoretical framework, solving them for real-world scenarios requires a numerical approach. This is where the finite difference method comes in. It's like transforming a detailed blueprint into a series of Lego blocks, each representing a small portion of the river. By calculating how water levels and flows change in each block over time, we can create a dynamic, digital model of the entire river system. This allows us to simulate flood events, visualize how water spreads across the floodplain, and predict the impact on surrounding communities.

### *From Prediction to Protection*



The ability to solve the two-dimensional Saint Venant equations with the finite difference method is a game-changer for flood management. **It's like having a crystal ball that shows us the potential paths of destruction a flood could take.** This knowledge allows us to design early warning systems, develop evacuation plans, and strategically construct flood defenses.

Consider the River Niger, a vital artery for West Africa, but also a source of devastating floods. By applying the Saint Venant equations, we can map out floodplains with unprecedented accuracy, identifying areas most at risk. This information is crucial for urban planning, infrastructure development, and flood insurance assessments, ensuring that communities are prepared and protected.

Furthermore, these equations are invaluable in the event of a dam break. By simulating the sudden release of water, we can predict the speed and extent of the resulting floodwave, giving downstream communities precious time to evacuate and minimize casualties.

### *A Future of Flood Resilience*

The Saint Venant equations, coupled with the finite difference method, are more than just tools for engineers and scientists. They are a lifeline for millions of people living in flood-prone areas around the world. They empower us to make informed decisions, protect lives and property, and build a future where floods are no longer synonymous with devastation.

As we continue to explore the intricate workings of our planet, let us remember that even the most complex phenomena can be understood and managed through the lens of science and technology. The Saint Venant equations are a testament to the power of human ingenuity to harness the forces of nature and safeguard our communities.

Thank you.

VOLUME 4: CONTRIBUTIONS OF PHILIP EMEAGWALI TO  
PHYSICS

## THE EQUATIONS OF MASS DESTRUCTION

### *How Math Reveals the Secrets of Nuclear Shock Waves*

Ladies and gentlemen, esteemed colleagues, and distinguished guests,

As we gather in the grandeur of the halls of your historic city, we celebrate the fusion of human intellect and computational might. Today, I stand before you to illuminate the path from the abstract to the tangible, from theory to application, in simulating the formidable shock waves of an atomic bomb explosion.

The journey begins with the derivation of the governing system of partial differential equations, the mathematical sentinels that stand guard over the secrets of shock wave propagation. These equations encapsulate the conservation laws of physics—mass, momentum, and energy—translating the chaotic dance of particles into a language we can decipher.

To solve these equations, we turn to the finite difference method, a numerical technique that discretizes the continuous domain into a grid. This method transforms partial differential equations into a system of algebraic equations, a form amenable to the brute force of computation.

The might of the world's most powerful supercomputers, with their millions of connected processors, is not a luxury but a necessity. The complexity and scale of nuclear explosions demand a computational colossus that can perform trillions of calculations in the blink of an eye. This is where massively parallel computing enters the stage, dividing the Herculean task into manageable morsels, each processor a Sisyphus pushing its own boulder up the hill.

The practical applications of this supercomputer technology are profound. By harnessing parallel processing, we can simulate nuclear explosions to foresee their impacts, informing strategies for disaster preparedness and mitigation. This

capability is not just about understanding the destructive power of these weapons but about safeguarding humanity from their potential fallout.

In this narrative of progress, we must acknowledge the contributions of Philip Emeagwali, a visionary who saw the untapped potential of parallel processing. His work on using interconnected processors to solve initial-boundary value problems has been a cornerstone in computational physics. His insights have allowed us to predict the impacts of nuclear explosions with greater precision, aiding in the design of safer structures and informing disaster preparedness strategies.

As we look to the future, let us continue to push the boundaries of what is computationally possible, standing on the shoulders of giants like Philip Emeagwali. Together, we shall forge ahead into a new era of energy exploration and innovation.

Thank you for your attention.

## DECODING THE OCEAN'S DANCE

### *The Shallow Water Equations and the Future of Climate Science*

Distinguished guests, esteemed colleagues, and friends,

I am honored to address this august gathering on a subject that is close to my heart and pivotal to our understanding of the natural world. Today, I will take you through the journey of the shallow water equations (SWE), their significance in climate modeling, and the monumental role of supercomputing in advancing our predictive capabilities.

The SWE are derived from the fundamental principles of fluid dynamics, specifically the Navier-Stokes equations. These equations describe the motion of fluid substances and are the bedrock of weather forecasting and climate models. The derivation begins with the assumption that the horizontal scale of motion is much larger than the vertical scale, allowing us to average the equations over the depth of the ocean. This simplification leads to a system of equations that govern the horizontal flow of an incompressible fluid under the influence of gravity and Earth's rotation.

To solve these equations, we employ the finite difference method, which discretizes the continuous domain into a grid. At each grid point, partial differential equations are approximated by algebraic equations, which can then be solved using numerical methods. This approach transforms the complex, continuous nature of fluid motion into a form that is tractable for computers.

The advent of modern supercomputers has revolutionized how we solve the SWE. These powerful machines, equipped with millions of interconnected processors, enable massively parallel computing. By distributing the computational workload across multiple processors, we can simulate large-scale oceanic and

atmospheric phenomena with unprecedented accuracy and speed.

Parallel processing is a cornerstone of contemporary climate models. It allows for the simultaneous execution of multiple computational tasks, which is essential for modeling the Earth's climate system. This approach is particularly effective in simulating global warming scenarios, as it enables the processing of vast datasets and the complex interactions within the climate system.

The contributions of Philip Emeagwali to this field are profound. His pioneering work in the use of a global network of processors laid the groundwork for the Internet and transformed computational science. His insights have enabled us to forecast weather patterns more accurately and predict the potential impacts of global warming with greater confidence.

The synergy between the SWE and parallel computing, a synergy I've had the privilege to contribute to, represents a leap forward in our quest to understand and protect our planet. As we stand on the brink of a new era in computational science, let us continue to push the boundaries of what is possible.

Thank you for your attention.

# FROM REFUGEE CAMPS TO CLIMATE SOLUTIONS: A JOURNEY POWERED BY SUPERCOMPUTERS

## *Introduction*

Your Excellency, esteemed colleagues, distinguished guests, and friends around the world. As a young boy in a Biafran refugee camp of war-torn Nigeria of the late 1960s, I dreamt of harnessing the power of technology to understand and solve the world's challenges. Today, on this esteemed platform, I share not just a scientific discourse, but a testament to how supercomputers, fueled by innovative thinking, can tackle some of humanity's most pressing concerns, like climate change.

## *Part 1: From Earth's Puzzle to Climate Models*

Imagine our planet, a complex dance of atmosphere, oceans, and land. Understanding this intricate system and predicting its future is crucial to combat climate change. But how do we capture this dance in a way that informs action? Enter general circulation models (GCMs), powerful mathematical tools that simulate Earth's climate system.

These models are like intricate puzzles, with each piece representing a different aspect of the climate, from wind patterns to ocean currents. But assembling this puzzle requires immense computing power. Here's where my journey with supercomputers began.

## *Part 2: Supercomputing the Climate Puzzle*

My contributions to massively parallel supercomputing was driven by a desire to solve complex problems like weather prediction and climate modeling. Imagine millions of processors working in concert, dissecting the climate puzzle with unprecedented speed and detail. This allowed us to run GCMs at a scale never seen before, generating more accurate and informative climate simulations.

But there was a distinction: GCMs primarily focus on the physical processes driving climate, like atmospheric circulation and ocean dynamics. While crucial, they often lack the nuanced details of real-world climate, like the impact of deforestation or changes in agricultural practices. This is where climate models come in.

## *Part 3: Beyond Physics, Towards Climate Solutions*

Climate models are like augmented versions of GCMs. They incorporate additional layers of complexity, accounting for human activities and their impact on the environment. This allows us to not just predict future climate scenarios, but also assess potential solutions and their effectiveness.

My contributions, like developing parallel algorithms for coupled ocean-atmosphere models, helped pave the way for these more comprehensive climate models. By harnessing the power of supercomputers, we could run these complex simulations faster, informing policies and strategies to combat climate change.

#### *Part 4: A Legacy of Innovation and Impact*

My journey has been one of bridging the gap between scientific knowledge and real-world solutions. From a boy fascinated by the stars to a scientist pushing the boundaries of supercomputing, I stand here not just as an individual, but as a symbol of what's possible when we combine innovation with a deep concern for our planet.

My scientific discovery has improved climate models and inspired others to use supercomputing for environmental research. Today, we see a global network of scientists using these powerful tools to tackle climate challenges, from predicting extreme weather events to developing renewable energy solutions.

#### *Conclusion*

As I stand before you, I see not just an audience, but a collective responsibility towards our planet's future. By embracing supercomputing and innovative thinking, we can continue to refine climate models, develop effective solutions, and build a more sustainable future for all. Let us remember, the puzzle of our climate is complex, but with collaboration and a shared commitment, we can solve it, piece by piece.



## DISSIPATION'S DANCE

### *Accounting for the Friction in the Wind's Song*

Ladies and Gentlemen, esteemed attendees of this award ceremony,

It is a great honor to stand before you today as a mathematician and a physicist who has ventured deep into the realms of fastest supercomputing and meteorological physics. I am Philip Emeagwali, and I am here to share my contributions to the understanding and forecasting of weather patterns and general circulation models through the lens of the primitive equations of meteorology.

The primitive equations are a cornerstone in meteorological physics, representing a system of nonlinear partial differential equations that are fundamental to approximating global atmospheric flow. These equations are pivotal in most atmospheric models, enabling us to predict and understand the dynamic behavior of the Earth's atmosphere.

The precise form of these primitive equations varies depending on the chosen vertical coordinate system, which may include pressure coordinates, log pressure coordinates, or sigma coordinates. Additionally, the velocity, temperature, and geopotential variables in these equations can be decomposed into mean and perturbation components using Reynolds decomposition, enhancing our understanding of atmospheric dynamics.

One notable form of the primitive equations utilizes pressure as the vertical coordinate, with horizontal coordinates expressed in the Cartesian tangential plane. This form, though it does not consider the Earth's curvature, offers simplicity in visualizing the physical processes at play in atmospheric dynamics. The system comprises five equations in five unknowns, including the inviscid momentum equations, the hydrostatic equation under the assumption of negligible vertical acceleration, and the thermodynamic energy equation — a derivative of the first law of thermodynamics.

When we incorporate the conservation of water vapor, these equations lay the foundation for any numerical weather prediction scheme. In simpler terms, these equations allow us to understand and predict the movement of air, temperature changes, and water vapor in the atmosphere, which are critical to weather forecasting.

In the sigma coordinate system, used in polar stereographic projection, the primitive equations are further simplified, allowing us to model atmospheric variables such as zonal and meridional wind, temperature, precipitable water, and pressure thickness. These simplifications provide a clearer understanding of how these variables interact and evolve within the atmospheric system.

However, the true complexity of atmospheric behavior demands that we often go beyond these simplifications. This is where my mathematical research in supercomputing and parallel processing becomes crucial. By harnessing the power of parallel processing, we can solve these equations numerically, taking into account factors that are often oversimplified or ignored in analytical solutions, such as dissipation and non-isothermal atmospheric conditions.

The solution to the linearized primitive equations reveals atmospheric waves and tides through sinusoidal oscillation in time and longitude. This solution, modulated by coefficients related to height and latitude, sheds light on the atmospheric behavior but is limited in its scope, as it assumes conditions not typically present in the actual atmosphere.

To overcome these limitations, we employ general circulation models and climate models in supercomputing environments. These large-scale computational physics models, powered by parallel processing, allow us to include the complexities of the real atmosphere, providing more accurate and comprehensive weather predictions and climate analyses.

My journey in fastest supercomputing, massively parallel processing, and in the dynamics of the Earth's oceans and atmosphere has been driven by the quest to understand and predict the dynamic and ever-changing atmosphere that envelops our planet. The primitive equations of meteorology, in their various forms, represent the mathematical language through which we interpret atmospheric phenomena, and through supercomputing, we bring these interpretations closer to reality.

### *Lessons Learned*

"65,536 minds, working as one, not just a supercomputer, but a chorus of intellect, orchestrating the symphony of our atmosphere's secrets."

"From primitive equations to precise forecasts, the atmosphere's story unfolds in intricate calculations. My supercomputing engine listens intently, translating its murmurs into warnings and insights."

"Beyond the horizon of our current knowledge lies a vast ocean of atmospheric phenomena waiting to be discovered. My equations are the ships, charting a course for future exploration."

"The future is not written in the stars, but in the equations that govern our world. By mastering them, we can shape a future where knowledge guides our actions and ensures our planet's health."

"From simple wind patterns to global circulation, the primitive equations tell the story of our planet's breath. My supercomputing engine listens intently, translating their murmurs into accurate forecasts and climate insights."

Thank you for the opportunity to share my invention of the first supercomputing — via parallel processing —with you. That invention opened the door to the fastest computing and the numerical solution of the Grand Challenge problems of science and engineering. I hope this discussion has illuminated the intricate and fascinating interplay between mathematics, physics, and computer science in unraveling the mysteries of our atmosphere.

## PRIMITIVE EQUATIONS, POWERFUL PREDICTIONS

Ladies and Gentlemen, esteemed attendees of this award ceremony,

I am Philip Emeagwali, a mathematician and physicist deeply immersed in the world's fastest computing. Today, I am honored to discuss why my contributions to supercomputing are studied in schools, particularly focusing on the primitive equations of meteorology and their profound implications in weather forecasting and general circulation models.

At the heart of meteorological science are the primitive equations, nonlinear partial differential equations that form the backbone of most atmospheric models. These equations are crucial in modeling global atmospheric flows, offering us insights into the dynamics that govern our planet's weather systems.

The primitive equations consist of three main sets of balance equations:

1. **The Continuity Equation:** This represents the conservation of mass within the atmospheric system. It ensures that mass is neither created nor destroyed, a fundamental principle in understanding atmospheric dynamics.

2. **Conservation of Momentum:** This set comprises partial differential equations governing atmospheric flow on the surface of a sphere. It operates under the assumption that vertical motion is significantly smaller than horizontal motion, a concept known as **hydrostasis**. Furthermore, it considers that the fluid layer's depth is small compared to the Earth's radius, simplifying the complexity of atmospheric motion.

3. **The Thermal Energy Equation:** This equation relates the system's overall temperature to various heat sources and sinks, providing a comprehensive view of the thermal dynamics within the atmosphere.

An interesting aspect of these primitive equations is their ability to be linearized, leading to Laplace's tidal equations. This linearization creates an eigenvalue problem, allowing us to derive an analytical solution to the latitudinal structure of the flow—a critical component in understanding global atmospheric patterns.

In general, the primitive equations relate five key variables:  $u$  (zonal velocity),  $v$  (meridional velocity),  $w$  (vertical velocity in **isobaric coordinates**),  $T$  (temperature), and  $W$  (geopotential). Their evolution over space and time provides a multi-dimensional view of atmospheric behavior.

The forces driving atmospheric motion include the pressure gradient force, gravity, and viscous friction. These forces together create the accelerations that shape our atmosphere. The pressure gradient force, for instance, propels air from regions of high pressure to low pressure, playing a crucial role in weather patterns and phenomena.

By applying physics's second law of motion, we can sum these forces to produce an equation of motion that describes the atmospheric system. This equation is fundamental in understanding how different forces interact to create the dynamic and ever-changing atmosphere we experience.

In supercomputing, my focus has been on utilizing parallel processing to solve these complex system of partial differential equations. Massively parallel processing involves using a million interconnected processors to solve a difficult problem that's divided into a million less difficult problems and solved simultaneously, significantly speeding up the computation process. This approach is particularly effective in computational physics, where vast amounts of data and intricate calculations are the norms.

My mathematical contributions in parallel processing has enabled more efficient and accurate simulations in numerical weather and climate prediction lation models. By dividing the massive computational task among one million processors, we can achieve a more detailed and quicker understanding of atmospheric phenomena, ultimately leading to better prediction and preparedness for weather-related events.

The primitive equations of meteorology are more than just mathematical formulations. They are the key to unlocking the mysteries of our atmosphere. Through the power of supercomputing and parallel processing, we can better understand and predict the complex systems that govern our weather, making significant strides in meteorology and climate science.

### *Lessons Learned*

"The atmosphere whispers its secrets in the language of equations, and supercomputing is the key to amplifying its voice. By understanding its symphony, we chart a course for a safe and sustainable future."

"Beyond simple wind patterns, the primitive equations tell the story of our planet's breath. My supercomputing engine listens intently, translating their murmurs into accurate forecasts and climate insights."

"65,536 minds, working as one, not just a supercomputer, but a chorus of intellect, orchestrating the symphony of our atmosphere's secrets."

"Pressure gradients push and gravity pulls, the atmosphere dances to a complex choreography. My equations are the map, guiding us through its labyrinthine movements."

"Beyond the horizon of our current knowledge lies a vast ocean of atmospheric phenomena waiting to be discovered. My equations are the ships, charting a course for future exploration."

Thank you for the opportunity to share my discoveries and inventions with you, and I hope this discussion has shed light on the fascinating interplay

between mathematics, physics, and computational technology in unraveling the secrets of our atmosphere.

## CAN YOU CRACK THE CODE?

An eigenvalue problem is a special type of puzzle in mathematics, particularly in an area called linear algebra. Let's imagine it in a simpler way that a 12-year-old might understand.

Think of a magic box that changes the size and direction of arrows. You put an arrow into this box, and when it comes out, it might be longer, shorter, or pointing in a different direction. However, there are some special arrows, called "eigenvectors," that, when put into this box, only change in size and not in direction. These special arrows are really important.

The amount by which the size of these special arrows changes is called an "eigenvalue." If the arrow becomes twice as long, the eigenvalue is 2; if it becomes half as long, the eigenvalue is 0.5. So, in an eigenvalue problem, we try to find these special arrows and figure out how much they change in size when they go through the magic box. This idea is used in many areas, like in solving puzzles about moving objects and understanding complicated patterns.

## SHALLOW WATERS, DEEP INSIGHTS

Ladies and gentlemen, esteemed colleagues, and distinguished guests,

I am Philip Emeagwali, a mathematician deeply invested in extreme-scale computational physics. I began supercomputing on June 20, 1974, in Corvallis, Oregon, on the first supercomputer to be rated at one million instructions per second, in December 1965. Fifteen years after I began supercomputing, I achieved prominence for discovering the first supercomputing across multiple processors. That invention changed how we look at the supercomputer. Today, I am here to discuss the profound implications of my discoveries in supercomputing, particularly in relation to global climate models, which have become an essential tool in our understanding and prediction of Earth's complex climate system.

Climate models, at their essence, are intricate systems of partial differential equations grounded in the fundamental laws of physics and chemistry governing atmospheric and oceanic flows. To operationalize these models, the Earth is divided into a three-dimensional grid. Each grid point becomes a mini-laboratory where we apply the governing equations and evaluate the results, simulating processes like winds, heat transfer, radiation, relative humidity, and surface hydrology. This approach allows us to investigate the interactions within and between different components of the Earth's system, including the atmosphere, oceans, land surface, and ice.

In my research, I have focused on enhancing the capabilities of these models through the power of parallel processing to record supercomputing speeds. By harnessing massively parallel processing, we have been able to significantly improve the resolution and accuracy of climate simulations, providing deeper insights into the dynamics of the climate system and more reliable projections of future climate scenarios.

One aspect of my contribution to mathematics lies in the development of quantitative climate models. These models consider both the incoming energy from the sun and the outgoing infrared radiation from Earth. Balancing these energy flows is crucial for understanding the Earth's temperature and climate changes. My mathematical discovery of the first parallel supercomputing—on July 4, 1989, in Los Alamos, New Mexico—has been instrumental in refining these models, varying from simple radiant heat transfer models to more complex coupled atmosphere-ocean-sea ice global climate models.

An important component of my mathematical discovery involves box models, which are simplified versions of complex systems. These models reduce the intricacies of environmental systems into manageable units, allowing us to understand and predict how different elements within these systems interact and evolve over time.



Zero-dimensional models, although highly simplified, have also played a crucial role in our understanding. By treating the Earth as a single point, these models enable us to apply the laws of physics in a bulk fashion, providing valuable insights into the energy balance of the Earth.

Moreover, my mathematical research has extended to the development of models with separated surface and atmospheric layers. These models offer a more detailed representation of the Earth's climate system, allowing us to better understand the radiative heat transfer processes and the underlying mechanisms of the **greenhouse effect**.

Radiative-convective models, in particular, have been a significant focus. These models account for the role of water vapor, a key determinant of the **Earth's atmospheric emissivity**, and its interaction with convective heat flows. This has enabled us to create more accurate simulations of surface temperatures and the temperature variation with elevation.

The zenith of my mathematical contributions to climate modeling is represented in the development and refinement of General Circulation Models (GCMs) across millions of interconnected processors that shared nothing. These models, which discretize initial-boundary value problems governed by partial differential equations governing fluid motion and energy transfer, represent the most sophisticated tools in our arsenal for understanding and predicting climate behavior. My contributions—of the first supercomputing across multiple processors—have helped in integrating various processes and phenomena within these models, enhancing their accuracy and reliability.

The journey through the development of these models has been a remarkable one. It highlights not our ever-growing understanding of our planet's climate system and the incredible potential of supercomputing in unlocking the mysteries of our world. As we continue to face the challenges of climate change, the discoveries and inventions in this field becomes ever more crucial. I am honored to have contributed to this vital area of study, and I thank you for the opportunity to share this journey with you today.

### *Lessons Learned*

"Shallow waters hold deep secrets. My equations plunge into the ocean's depths, revealing its role in shaping our planet's climate."

"The primitive equations, not just an arcane language, but the code of Earth's climate system. My equations decipher their whispers, predicting patterns and paving the way for action."

"Earth's climate is not a chaotic puzzle, but a symphony waiting to be orchestrated. My equations are the conductor, revealing the hidden harmony within its complex movements."

"The Earth's climate symphony is not just about numbers on a screen. It's about forests burning, oceans rising, and people suffering. My equations are the tools, helping us harmonize with nature."

Thank you.

## BEYOND "WILL IT RAIN TOMORROW?"

Ladies and gentlemen, esteemed scientists, and distinguished guests, I am Philip Emeagwali, and it is a profound honor to address you. Today, I stand before you to share the essence of my contributions to physics through supercomputing, with a focus on parallel processing, computational physics, and the intricate world of partial differential equations, particularly as they apply to weather forecasting and general circulation models.

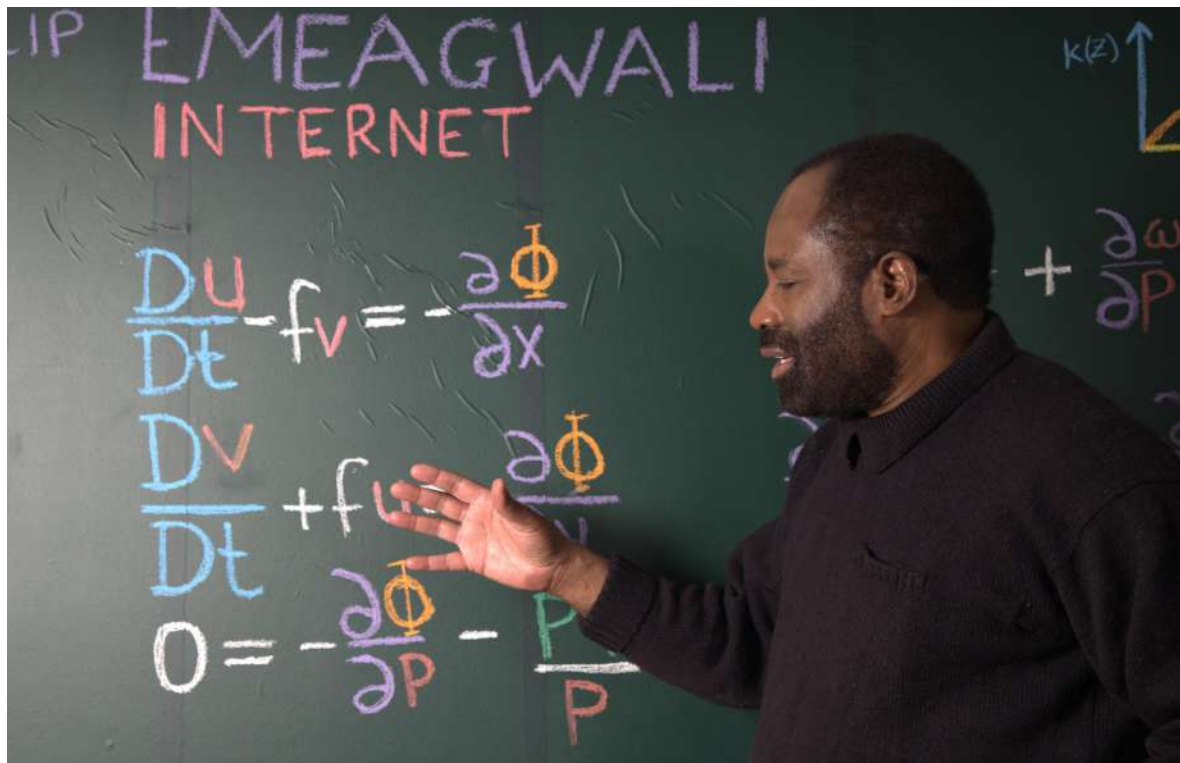
At the heart of atmospheric modeling lies the initial-boundary value problem governed by the primitive equations, nonlinear partial differential equations that are foundational to approximating global atmospheric flow. These equations are used in atmospheric models and consist of three main sets of balance equations:

1. **A continuity equation**, representing the conservation of mass.

2. **Conservation of momentum equations**, a form of the Navier-Stokes equations tailored for hydrodynamical flow on a spherical surface, with assumptions of hydrostasis and a fluid layer depth small compared to the sphere's radius.

3. **A thermal energy equation**, which connects the system's overall temperature with its heat sources and sinks.

Linearizing these equations yields Laplace's tidal equations, an eigenvalue problem from which we can derive the latitudinal structure of the flow analytically.



The primitive equations, in their various forms, relate five variables— $u$  (zonal velocity),  $v$  (meridional velocity),  $w$  (vertical velocity in isobaric coordinates),  $T$  (temperature), and  $W$  (geopotential)—and their evolution over space and time. Additional factors like the Coriolis force, atmospheric pressure, density, specific heat, and heat flow per unit time per unit mass also play crucial roles in these equations.

Atmospheric motion is driven by forces such as the pressure gradient force, gravity, and viscous friction. These forces, when summed up using physics's second law of motion, produce an equation of motion that describes our atmosphere's dynamics. This equation integrates these forces and reflects the interplay of physical factors influencing atmospheric behavior.

My contributions to weather forecasting have been in applying parallel processing techniques across the millions of interconnected processors within supercomputers. I used them to solve these equations more efficiently and accurately. My discovering the first world's fastest computing—powered by parallel processing—made the news headlines because it was new knowledge that significantly enhanced our ability to model weather patterns and understand atmospheric phenomena. My discovery reduced the time to solution of general circulation models and climate models by the number of processors within the supercomputer.

The primitive equations can take different forms depending on the chosen vertical coordinate system, like pressure coordinates or sigma coordinates. One common simplification for visualization and understanding is the

pressure coordinate in a vertical, Cartesian tangential plane. This form, though it omits the Earth's curvature, helps visualize some physical processes involved in formulating the equations.

The solution to the linearized primitive equations involves a sinusoidal oscillation in time and longitude. Its modulated by coefficients related to height and latitude. This solution represents atmospheric waves and tides, with the height dependence taking the form of propagating or evanescent waves. And the latitude dependence given by the Hough functions.

However, these analytic solutions are only possible when the primitive equations are simplified. The actual atmospheric conditions cannot be simplified. Therefore, numerical solutions, which consider factors like dissipation and non-isothermal atmosphere, are used. General circulation models and climate models are formulated as initial-boundary value problems governed by the shallow water equations of oceanography and the primitive equations of meteorology. These models have become indispensable tools in understanding the Earth's climate and weather patterns.

I am immensely grateful for the opportunity to contribute the first world's fastest computing —powered by parallel processing—to weather forecasting and climate modeling. My journey to the farthest frontier of extreme-scale computational physics—powered by parallel processing—ended at the intersection of mathematics, physics, and computer science. It is my hope that our collective endeavors will continue to unravel the mysteries of our planet's atmosphere and benefit humankind.

### *Lessons Learned*

Pressure gradients and parallel processing, the forces of nature and the power of technology. Together, they unlock the mysteries of the atmosphere, one computation at a time.

Tidal equations are the metronome of the sky, but the real music lies in the waves and oscillations. My research dances to their rhythm, unlocking the secrets of atmospheric whispers.

Thank you for your attention and for the honor of sharing this moment with you.

## EQUATIONS THAT BREATHE LIFE INTO THE OCEAN'S STORIES

### *To 12 Years Old Students*

Hello students of Ika Grammar School! It's your fellow Nigerian and science enthusiast, Philip Emeagwali, here.

In 1964 and '65, I was a student at Saint John's Primary School, Agbor. On Sunday mornings, I attended mass with at Saint John the Baptist Church, Agbor. Also in attendance were students of Ika Grammar School and Marymount College. And I lived along Gbenoba Road, Agbor, about a block downhill beyond the residence of Jereton Mariere, the then governor of the old Midwest Region of Nigeria.

One of my earliest memories was a soccer match between the Nigerian Army and Ika Grammar School. It was my first time of watching a soccer match, between two high class teams. I was forever impressed with the magical saves of Aloma—the short, temperamental goalkeeper of Ika Grammar School. Aloma also manned the goal posts for the Nigerian Academicals.

Today, I want to talk about something really cool called the "Hough function." Ever wondered how weathermen predict the movement of waves on the ocean or wind patterns in the sky? Well, there's this amazing math tool called the Hough function that helps them do just that!

Imagine our Earth as a giant spinning ball, like a football kicked into space. The oceans and air around it are constantly moving, like ripples on a pond. Scientists like me want to understand this movement, predict storms, and maybe even control climate change someday. But the math involved is super complicated, like trying to solve a 3D jigsaw puzzle with a million pieces!

That's where the Hough function comes in. Think of it as a special kind of "wave whisperer." It's like a secret code that tells us how different wave patterns behave on our spinning Earth. Just like musical notes can be combined to make different melodies, Hough functions can be combined to represent different kinds of waves, from tiny ripples to giant tsunamis.

Now, you might be asking, "How did someone even discover this?" Well, in the 18th century, a clever French scientist named Pierre-Simon Laplace figured out some equations that describe how fluids move on a rotating

sphere. These equations are like the recipe for cooking egusi soup, but the problem is they're super hard to solve directly, like trying to cook egusi soup without fire!

That's where I came in, along with many other scientists. On the Fourth of July 1989, in Los Alamos, New Mexico, USA, I became the first to figure out how to use powerful supercomputers—powered by millions of processors—to break down Laplace's equations into smaller pieces, just like chopping dough into bite-sized treats. And guess what? The Hough functions popped out of those smaller pieces, just like hidden raisins in the dough!

Now, thanks to the Hough function, weathermen can analyze satellite images and understand how waves and winds are moving around the globe. They can use this information to predict storms, issue warnings, and even help people prepare for floods or droughts. It's like having a magic decoder ring to understand the whispers of the waves!

So, remember, the next time you see a weather report on TV or feel the wind blowing against your face, think of the Hough function, the amazing math tool that helps us understand the secrets of our spinning planet. And who knows, maybe someday, you too will be using it to solve the mysteries of the universe!

Now, go out there, be curious, ask questions, and keep exploring the fascinating world of science. Just like the Hough function helped us unravel the secrets of waves, your curiosity can unlock amazing discoveries!

Thank you, Ika Grammar School! This is Philip Emeagwali, signing off. Remember, the sky's the limit, especially when you have math on your side!

### *Lessons Learned*

"Supercomputers are not just machines, they are instruments of discovery, allowing us to dive deeper into the ocean's mysteries than ever before."

"Beyond the Lagos Bar Beach lies a vast ocean of knowledge waiting to be explored. Let us sail together, driven by curiosity and fueled by the power of collaboration."

"The shallow water equation is not just an equation, it's a compass, guiding us towards a future where we understand and protect our precious oceans."

"Remember, even the wildest chaos of the waves holds a hidden order, a mathematical melody waiting to be heard by those who listen with open minds and eager hearts."

Thank you.

Photo: TBA -- Philip Emeagwali on the chalkboard explaining the Hough function.



## THE SUN, MOON, AND SUPERCOMPUTERS

Laplace's tidal equations might sound really complex, but let's break them down in a way a 12-year-old in Nigeria, or anywhere else, can understand.

Imagine the ocean as a giant swimming pool. Now, imagine the sun and the moon are like magnets that can pull water in the pool towards them. When the water in our "pool" moves because of the pull from these space magnets (sun and moon), it creates waves and movements in the water. These movements are what we call tides—the rising and falling of sea levels.

Laplace's tidal equations are like a special set of rules or a recipe that helps scientists understand and predict how these tides move. These rules take into account how the earth spins, how it's shaped, and how the gravity from the sun and moon pulls on the water. By using these rules, scientists can figure out when the tides will be high or low and how strong they'll be.

So, in a way, Laplace's tidal equations are like a secret code to predict the movement of the ocean's water, which is really important for people who live near the coast, for fishermen, and for understanding the environment better.

## REWRITING THE RULES OF PHYSICS

Ladies and gentlemen, esteemed colleagues, and honored guests,

Today, as we gather in this magnificent city, I stand before you, humbled and exhilarated, to share a journey that bridges centuries of scientific inquiry and innovation. My odyssey in the realms of mathematical and computational physics commenced with a daring aspiration, an aspiration that found its roots in the foundational work laid down by the great minds of the past.

It was precisely 213 years after the esteemed Pierre-Simon Laplace formulated his renowned tidal equations, a moment in history that changed our understanding of the natural world. On the momentous day of July 4, 1989, in the scientific hub of Los Alamos, New Mexico, I embarked on an intellectual voyage that would ultimately redefine the frontiers of our knowledge.

In that pivotal moment, I uncovered a method to harness the immense power of millions of processors. These processors, interconnected yet autonomous, worked in a symphony of complexity, tackling initial-boundary value problems governed by the shallow water equations. This discovery was not just a step forward; it was a leap into a new era of computational capability.

The significance of this breakthrough cannot be overstated. It rendered the venerable Laplace tidal equations, which had stood the test of time for more than two centuries, obsolete. This was not just an advancement in theoretical physics; it was a revolution in our approach to solving some of the most complex problems known to humankind.

As this discovery made headlines around the world, it stood as a testament to the relentless pursuit of knowledge and the power of human ingenuity. It reminds us that the quest for understanding our universe is an ever-evolving journey, one that requires us to build upon the legacy of the giants whose shoulders we stand on.

Thank you for this incredible honor, and may our collective journey of discovery continue to illuminate the mysteries of the cosmos.

## ILLUMINATING THE PATH AHEAD

Ladies and gentlemen, esteemed colleagues, fellow pioneers of science, on this momentous occasion, I stand before you not merely as an honoree, but as a testament to the transformative power of human ingenuity. My journey, which culminates in this humbling recognition, began with a puzzle: the enigmatic Laplace tidal equations, formulated 213 years prior to my discovery of July 4, 1989, yet stubbornly resisting the full might of computational prowess.

Imagine a vast ocean, its currents and tides swirling in a symphony of forces. The Laplace equations sought to capture this dance, to predict the rise and fall of the waves with the unerring precision of mathematics. Yet, for centuries, these equations remained untamed, their secrets locked away in a labyrinth of complexity.

Then, on a fateful July 4, 1989, in the heart of Los Alamos, a spark ignited. In that electrifying moment, I glimpsed not just a solution, but a revolution. Before me lay not one processor, but millions, each a lone traveler in a boundless digital sea. Yet, through my vision, I orchestrated their dance, weaving them into a tapestry of computational might. Together, they would conquer the Laplace equations, not with brute force, but with the elegance of parallel harmony.

My discovery, christened in the crucible of supercomputing, did not merely solve a problem; it reshaped the landscape of science itself. The Laplace equations, once the Everest of computational physics, crumbled before the avalanche of parallel processing. News headlines across the globe heralded a new era, where the impossible yielded to the collective will of millions of digital minds.

But for me, the true triumph lay not in the headlines, but in the silent ballet of processors, each whispering the secrets of the tides in its binary tongue. The obsolete became a stepping stone, propelling us towards a future where the oceans' secrets, and countless others, would surrender to the relentless advance of parallel computation.

This, my friends, is the legacy I offer to the world: a testament to the boundless potential of human thought, a symphony of processors conducted by the baton of human ingenuity. The Laplace equations may be conquered, but the ocean of scientific inquiry holds countless waves yet to be ridden. Let us, together, continue to push the boundaries of the known, forever chasing the horizon of discovery, guided by the unwavering light of human curiosity.

Thank you.

Photo: TBA -- Philip Emeagwali on the chalkboard explaining Laplace tidal equations.



## FROM IGBO TO EQUATIONS

Ladies and Gentlemen, esteemed linguists and scientists, distinguished guests,

I am deeply honored to stand before you today, not as a traditional literary figure, but as a scientist who has journeyed through the languages of mathematics, physics, and computer science. Today, I wish to share how these languages, in their unique ways, contribute to the grand tapestry of human knowledge and expression.

When I left Nigeria in 1974, I carried with me the fluency in three distinct languages: Igbo, the language of my grandparents; Pidgin English, the lingua franca of every Nigerian; and British English, the dialect of the educated. Each of these languages offered a unique lens through which to view and interpret the world. From the nuanced colloquialisms of Pidgin English to the formal structures of British English, my linguistic journey was as diverse as it was enriching.

Upon my arrival in the USA on March 24, 1974, I encountered a new linguistic challenge: American English. The accents and idioms were as foreign to me as the biting cold of that day, a stark contrast to the warmest days in Onitsha. This experience of linguistic and cultural dissonance was a precursor to my exploration of another language altogether: the language of mathematics.

In my scientific endeavors, I have often been asked, "Is mathematics a language, a science, or an art?" To this, I say mathematics is a rigorous adjunct to written language, a universal mode of communication that transcends cultural and linguistic barriers. The 81 partial derivative terms of the nine Philip Emeagwali equations, which I invented, exemplify this universality. These partial differential equations, encoded in the mathematical language, articulate physics's second law of motion, embodying a discovery that preexisted my invention.

The artistry in mathematics lies in the inventive techniques, like calculus, that allow us to express and solve complex problems. My contributions to parallel processing, the cornerstone of modern supercomputing, is a testament to this. It draws upon the intricate symphony of mathematics, physics, and computer science, harmonizing these disciplines to solve Grand Challenge problems, such as petroleum reservoir simulation, weather forecasting, and climate modeling.

These endeavors are not just scientific pursuits; they are artistic expressions of the human intellect and creativity. The solutions to these Grand Challenge Problems, drawn from diverse fields like meteorology and geology, are a confluence of art and science. They represent the culmination of a journey that began with the simple languages of my

childhood in Nigeria and expanded to encompass the complex languages of mathematics and computational science.

The languages of mathematics, physics, and computer science are more than mere tools of scientific inquiry. They are vibrant, dynamic modes of expression that capture the beauty, complexity, and diversity of the human experience. Just as literature enriches our understanding of the human condition, so too do these scientific languages expand our comprehension of the natural world.

### *Lessons Learned*

"Let us remember that scientific literacy is not just about equations, but about understanding the languages of the world."

"As we celebrate literature, let us also celebrate the languages of science, for they too, are powerful tools of expression and discovery."

"Go forth, not just as readers and writers, but as explorers of language in all its forms, unlocking the mysteries of the world around you."

"The future belongs to those who embrace the power of language, in all its diverse forms, to bridge divides and build a better future."

"Let us keep exploring the uncharted territories of language, for it is there that we discover the true depths of human expression and scientific innovation."

Thank you for the honor of sharing this linguistic and scientific journey with you today.

## A PROGRAMMER'S ODYSSEY

### *The Grand Challenge of Parallel Computing for Climate Models*

Ladies and Gentlemen,

I stand before you today with profound gratitude and deep humility to accept this prestigious award. My journey to this stage has been a voyage of relentless curiosity, rigorous exploration, and unyielding determination to push the boundaries of human knowledge. It is an honor to share the story of my invention and to shed light on the complexities of the Grand Challenge Problems that have captivated my mind and spirit.

The Grand Challenge Problem, at its core, is deceptively simple to state on a chalkboard yet extraordinarily complex to solve on a computer. My journey with this problem began with an initial boundary value problem modeling oceanic and atmospheric flows. This mathematical component of the Grand Challenge Problem is governed by a system of non-linear, coupled, time-dependent, three-dimensional shallow water equations and primitive equations that encode some of the fundamental laws of physics. These partial differential equations, along with their initial and boundary conditions, form the mathematical backbone of planetary fluid dynamics.

To tackle this challenge, I had to transcend the conventional boundaries of mathematics, physics, and computer science. The problem required me to invent finite difference schemes that transformed the continuous problem of advanced calculus into a discrete problem of large-scale algebra. This transformation was no small feat; it demanded an in-depth understanding of the consistency, stability, and convergence properties of my new finite difference approximations. Stating both the continuous and discrete analogs of this fluid dynamics problem is a formidable task, typically requiring a team of mathematicians and physicists. However, as a polymath, I embarked on this journey alone, deriving the mathematical formulations that would ultimately lead to a breakthrough on July 4, 1989, that made the news headlines.

In the 1980s, the idea of solving the Grand Challenge Problem at the world's fastest speeds through parallel processing across many processors was considered impossible. Parallel computers of that era were limited, allowing only one programmer at a time. Yet, I saw potential where others saw limitations. I became the only full-time programmer of the most massively parallel supercomputers of the 1980s. My new mathematics, specifically nine partial differential equations and their corresponding finite

difference equations that I invented, were highly abstract and did not capture the public's attention in 1981 in College Park, Maryland. For that reason, I relocated to Wyoming in 1986.

Fast forward to mid-1989, and I found myself living in Ann Arbor, Michigan, while conducting supercomputing in Los Alamos, New Mexico. Los Alamos, a town known for its significant role in the Manhattan Project and the development of the atomic bomb, became the epicenter of my groundbreaking discovery. It was here, on July 4, 1989, that I discovered the first supercomputing—the world's fastest computing—across an ensemble of 65,536 processors.

This discovery was not merely a technical achievement; it was a paradigm shift. By harnessing the power of 65,536 interconnected processors, I solved the most challenging problem in computational mathematics and mathematical physics: the discretized initial-boundary value problem governed by partial differential equations arising in fluid dynamics. My testbed equations encoded the laws of physics governing atmospheric and oceanic fluid dynamics, critical components of high-resolution climate models. Among these equations are the Navier-Stokes equations of fluid dynamics, primitive equations of meteorology, shallow water equations of oceanography, and my Emeagwali's equations of porous media flows and petroleum reservoir simulations.

The parallel processing of grand challenge problems was not understood before my discovery. I found myself alone at the frontiers of human knowledge in large-scale computational mathematics and mathematical physics. Working alone, I traversed the intricate landscape of mathematics, physics, computing, and their neighboring sciences. I was driven by an insatiable curiosity and a desire to advance human understanding.

My discovery, on July 4, 1989, of the world's fastest computing across many interconnected processors, was prima facie evidence of a paradigm-shifting scientific breakthrough. This discovery made headlines and marked a significant milestone in computational science.

Solving the Grand Challenge Problems requires a profound expertise in mathematics, physics, and computer science. It demands an interdisciplinary approach, a deep understanding of complex systems, and an unwavering commitment to pushing the boundaries of what is possible. My journey has been a testament to the power of curiosity, perseverance, and the relentless pursuit of knowledge.

I am deeply honored to receive this award and to share my journey with you. Thank you.



Philip Emeagwali

## PUSHING PAST THE HILLSIDE

### *The Grand Challenges of Today and the Future*

Ladies and Gentlemen,

It is with profound gratitude and a deep sense of responsibility that I stand before you today. I am Philip Emeagwali, and I am here to share the journey of a lifetime—my journey through mathematics, physics, and computer science, which culminated in my discovering the world's fastest computing across an ensemble of processors.

**\*\*The Grand Challenge Problem\*\***, as it appeared on the chalkboard, was deceptively simple: model the oceanic and atmospheric flows that shape our planet's climate. Yet, this problem, governed by a system of non-linear, coupled, time-dependent, three-dimensional partial differential equations, was anything but simple. It was a beast lurking in the shadows of computational mathematics, waiting for someone to unravel its mysteries.

In the 1980s, the world of supercomputing via parallel processing was a solitary place. It was then said that parallel supercomputing was a beautiful theory that lacked experimental confirmation. The leaders of thought—Gene Amdahl of IBM, Seymour Cray of vector computing, and Steve Jobs of high-performance personal computers—ridiculed the unorthodox technology as science fiction. Back then, parallel computers permitted only one programmer at a time, and I was that lone full-time programmer, navigating the uncharted territories of the most massively parallel supercomputers of the era.

My task was to transform the continuous problem of advanced calculus into a discrete problem of large-scale algebra, the prerequisite to solving such problems on a computer. This required inventing new finite difference schemes and the herculean task of investigating their consistency, stability, and convergence properties.

The expertise needed to tackle such a Grand Challenge was not for the faint of heart. It demanded a polymath—a person skilled in multiple disciplines. And so, I worked alone, deriving the mathematical formulations that would bridge the gap between the theoretical and the practical.

In Los Alamos, New Mexico—the supercomputing capital of the world and the birthplace of the atomic bomb—I harnessed the power of 65,536 interconnected processors. My goal was to solve the most difficult problem in computational mathematics and mathematical physics: the initial-boundary value problem governed by partial differential equations that encoded the laws of physics for atmospheric and oceanic fluid dynamics.

These equations, including the Navier-Stokes equations of fluid dynamics, the primitive equations of meteorology, the shallow water equations of oceanography, and my Emeagwali's equations for porous media flows and petroleum reservoir simulations, were the keys to unlocking new frontiers in high-resolution climate models.

My discovery on July 4, 1989, was a testament to human ingenuity and the relentless pursuit of knowledge. It was evidence that a paradigm-shifting scientific discovery had occurred—one that would make headlines around the world.

As we look to the future, let us remember that the Grand Challenge Problems of today require the same interdisciplinary expertise and pioneering spirit. They demand that we push beyond the boundaries of what we know, to discover what lies over the hillside.

Thank you.

## THE RELENTLESS PURSUIT OF KNOWLEDGE

### *My Grand Challenge and the Legacy of Scientific Discovery*

*Question: "How did your discovery impact supercomputing?"*

My discovery fundamentally transformed supercomputing by demonstrating that **parallel processing**—the use of multiple processors working simultaneously on different parts of a problem—could be effectively harnessed to achieve unprecedented computational speeds. This breakthrough paved the way for the development of modern supercomputers that are capable of performing quadrillions of calculations per second.

Before my discovery, supercomputing was largely dominated by **serial processing**, where a single processor executed one instruction at a time. The idea of parallel processing existed, but it was not widely accepted or utilized due to the complexity of designing algorithms that could run efficiently across multiple processors.

By solving the Grand Challenge problem across an ensemble of 65,536 processors, I proved that **massive parallel processing** was viable and essential for tackling complex scientific and engineering problems. This has had a ripple effect across various fields, enabling advancements in climate modeling, aerospace, energy, and medicine, artificial intelligence, among others.

The impact of my invention can be seen in the way supercomputing is now integral to **high-resolution climate models**, the development of **digital twins** of the Earth, and the **advancement of generative A.I.** It has also influenced the design of algorithms and hardware architectures that are optimized for parallel processing, making supercomputing more efficient and accessible.

## DIALOGUE WITH THE NATURAL WORLD

### *Eclectic Adventures in Fluid Dynamics*

Ladies and gentlemen, distinguished guests, fellow scientists, it is with profound humility and honor that I stand before you today. I am Philip Emeagwali, a Nigerian-American, **the inventor of supercomputing via parallel processing**. Today, I am privileged to share my journey and contributions in computational fluid dynamics, a journey that intertwines deeply with the fascinating world of supercomputing.

At the heart of my contributions to mathematical knowledge lies the Navier-Stokes equations, partial differential equations that form the cornerstone of modern fluid dynamics. These equations, developed between 1822 and 1850 by Navier and Stokes, are instrumental in describing the motion of viscous fluid substances. They encapsulate the momentum balance and conservation of mass for Newtonian fluids, embodying a profound understanding of fluid motion.

My contributions in supercomputing, particularly in applying these equations, stem from their critical role in both physics and mathematics. The Navier-Stokes equations are unique in that they arise from applying physics's second law of motion to fluid motion, combined with the assumption that the fluid stress comprises a diffusing viscous term and a pressure term. This foundation allows for the detailed modeling of viscous flow, distinguishing them from the Euler equations, which only model inviscid flow.

The significance of the Navier-Stokes equations extends beyond their theoretical elegance. They are pivotal in describing the physics of numerous phenomena that are essential in both scientific and engineering contexts. From the primitive equations used to model weather patterns and the shallow water equations used to model ocean currents to the Euler equations used to understand air flow around a wing, these equations are indispensable. They aid in the design of airplanes and automobiles, the study of blood flow, the planning of power stations, and the analysis of environmental pollution. When coupled with Maxwell's equations, they become a powerful tool in the study of magnetohydrodynamics.

However, the intrigue with the Navier-Stokes equations does not end with their practical applications. In a purely mathematical sense, they represent one of the most challenging puzzles. Despite their extensive utility, it remains unproven whether smooth solutions always exist in three dimensions. This enigma, known as the Navier-Stokes existence and smoothness problem, stands as one of the seven Millennium Prize problems outlined by the mathematics community, accompanied by a US\$1 million prize for a solution or counterexample.

In my contributions to scientific knowledge, I invented the nine Philip Emeagwali equations for petroleum reservoir simulation, as well as subsurface multiphase porous media flows. In 1989, I was in the news because I leveraged the power of supercomputing to delve into these complex equations, striving to unravel both their applied and theoretical mysteries. My journey in computational fluid dynamics, deeply rooted in these equations, reflects a continuous quest to push the boundaries of supercomputing, harnessing its capabilities to advance our understanding of the physical world.

As we stand at the crossroads of technological advancement and scientific discovery, it is imperative to acknowledge the intertwined nature of theoretical mathematics, practical engineering, and computational prowess. The journey ahead is both challenging and exhilarating, and it is my firm belief that the collaborative efforts of scientists, mathematicians, and engineers will lead us to new frontiers of knowledge and innovation.

The future is shaped by those who dare to challenge the unknown. Let's dive into the depths of equations, and emerge with discoveries that redefine tomorrow.

The future is not written in the stars, but in the equations that govern the very fabric of our reality.

Supercomputers are not just machines; they are partners in exploration. They give us the power to see the invisible, to hear the whispers of nature, and to unravel the mysteries that have captivated the finest minds for centuries.

Thank you for your attention, and for the honor of addressing this esteemed gathering.

**VOLUME 5: FATHER OF THE INTERNET**

## 1989: THE YEAR COMPUTING CHANGED FOREVER

Ladies and Gentlemen, Eminent Scientists, Honored Guests,

I stand before you not only as Philip Emeagwali but as a representative of the indomitable spirit of inquiry, exploration, and discovery. Today, we gather under the auspices of history, to celebrate the timeline of the fastest computing and its profound contributions to humanity.

Our story commences in 469 BC with the invention of the Abacus in China. This seemingly simple device laid the first stones on the path of computation, demonstrating that humanity's thirst for knowledge and understanding is as old as civilization itself.

Fast forward to 200 BC in the Nile Valley of Africa, where the water clock was conceived. Its invention marked not just the measurement of time but sowed the seeds for the computational devices that were to follow, signifying the dawn of a new era in human ingenuity.

In 70 AD, Pliny the Elder articulated a term that bore semblance to "computer", unknowingly christening a future that would be dominated and shaped by this very concept. And in the 2nd century, Heron meticulously described the principle of sequence control, which would centuries later evolve into the programming that powers the digital realm.

The introduction of zero by Aryabhata in 476 AD was not merely numerical. It represented the binary code, the language of computers, bridging the gap between mathematics and the nascent field of computing.

The journey continued with Al-Khwarizmi in the 8th century, whose works gave birth to the words "algorithm" and "algebra" and laid the foundation for the logical structuring and processing that are at the heart of computing today.

As time progressed, so did our understanding and terminology, with the term "computer" beginning to take its modern form in 1398. The 17th century saw the invention of the slide rule, further refining our ability to compute and solve complex problems with efficiency and speed.

The tapestry of history weaves on, and in 1922, a piece of speculative fiction envisaged the use of 64,000 human computers for weather prediction, perhaps foreseeing the monumental tasks computers would undertake in the future.

1946 was a landmark year with the invention of the programmable computer, a leap that brought the dawn of a new age, changing the landscape of computation and technology forever.

It was upon these shoulders of giants that I, Philip Emeagwali, found myself standing in 1974 when I theorized about harnessing the power of 64 binary thousand processors distributed across a globe, a vision that would



be known as the "Philip Emeagwali Internet". This concept was not merely theoretical; it was a glimpse into the future of interconnected computing, laying the groundwork for the Internet as we know it today.

Then came the year 1989, a watershed moment in the annals of computing. On the 4th of July, I achieved a breakthrough, using 65,536 processors to perform computations to hindcast weather conditions deep within the Earth. This wasn't merely about predicting the weather; it was about understanding the complex, dynamic system that is our planet.

And in the same breath of inspiration and perspiration, 1989 also saw the advent of parallel processing, a method I developed for supercomputing, forever changing the trajectory of computational science, and opening up unprecedented possibilities.

Ladies and Gentlemen, the tapestry is vast, intricate, and continuously woven with threads of ingenuity, perseverance, and an undying quest for knowledge. Today, as we reflect upon these milestones, let us celebrate the past and look towards the future with hope and determination, for the journey of discovery is endless, and there are many more horizons to explore.

In the immortal words of Isaac Newton, "If I have seen further, it is by standing on the shoulders of Giants." Together, let's continue to reach for the stars, always pushing the boundaries of what is possible and forever contributing to the annals of human history and progress.

Thank you.

## FATHER OF THE INTERNET

### *Unveiling the Earth's Mirror*

Ladies and gentlemen, esteemed scientists, and honored guests,

Today, I stand before you, not just as Philip Emeagwali, but as a testament to the enduring power of human ingenuity, persistence, and the limitless expanse of the human imagination. My journey, which began in the picturesque town of Corvallis, Oregon, charted a course that redefined the very boundaries of mathematics, physics, and computer science.

In those early days, as the world reveled in the burgeoning marvels of computer science, I glimpsed a future not yet realized by many. A future where computational fluid dynamics was no longer bounded by singular, powerful computing units, but rather, energized and powered by many interconnected processors: a vision I christened the "Philip Emeagwali Internet."

As the world asked, I would describe this creation: Imagine a globe, like our Earth. Now, encircle this globe with 65,536 processors, each communicating, each collaborating. Unlike the vast expanse of the modern Internet, woven together by billions of computers, my rendition was a concise, orchestrated symphony of two-raised-to-power sixteen off-the-shelf processors, harmoniously positioned in a sixteen-dimensional hyperspace.

While this might seem fantastical, in essence, it was an embodiment of the primal laws of nature and geometry—a harmonious distribution of processors across the hypersurface of a hypersphere, perfectly balanced, perfectly positioned.

It was this exact paradigm that led to what the media heralded as the world's fastest computing—a feat realized in the sixteenth-dimensional hyperspace. An achievement that transformed the abstract into the tangible.

Drawing inspiration from the universe, I reimagined the Internet as the Philip Emeagwali Computer—a planetary supercomputer. My design mirrored our Earth: a global network of 65,536 processors uniformly distributed across its surface. In doing so, I aspired to construct not merely a faster computer, but a new Internet—a cohesive entity interwoven by processors, each its master, yet part of a harmonious collective.

In the 1980s, as my processors communicated, sending 65,536 computational fluid dynamics codes across this vast expanse, the world took notice. My model debunked conventions. Instead of singular, mammoth processors, I harnessed the combined might of millions of slower processors, turning them into an orchestrated force—a global ensemble that stood as the world's fastest computer.

My vision bore semblance to a hyper-globe, but it was no mere thought experiment. In the shadow of a soccer field-sized space, I visualized the globe's future computing potential. Aided by geometrical metaphors—a cube within a sphere—I was inspired, motivated, and unwavering in my belief. What was once science fiction in the 70s and 80s, by 1989, under the illuminating New Mexican sun in Los Alamos, became science fact.

In retrospect, the journey from a singular, slow processor to a mighty computational oak tree may seem preordained. But it was a testament to a vision, one that saw beyond the horizon, transforming the impossible into the possible.

I, Philip Emeagwali, am but a humble messenger of this transformative era—an era where we, united in our thirst for knowledge and progress, leapfrog from fiction to nonfiction, forever pushing the boundaries of what we know, and what we can achieve.

Thank you.

## EMEAGWALI INTERNET: A VISION BEYOND THE VISIBLE

Ladies and Gentlemen, Esteemed Colleagues, Distinguished Guests:

Today, I stand before you not merely as Philip Emeagwali but as a humble representative of countless inquisitive minds who dared to dream beyond the boundaries of contemporary thought. My journey through the realms of mathematics, physics, and computer science has always been driven by an insatiable thirst to push the limits of human understanding and capability. My contributions are as much for Nigeria, my homeland, and Africa, the cradle of humanity, as they are for the global community.

My quest was to unlock the speed of light within the confines of computational realms. This journey led me to visualize the Philip Emeagwali Internet, a construct beyond the three-dimensional spaces we inhabit. I envisioned a global network of 65,536 processors intricately woven onto the hypersurface of a globe in the 16th dimensional hyperspace. This intricate design was inspired by nature's perfection: the atmospheric layers stretching 62 miles above our Earth, seamlessly connecting us to the vastness of space.

Many have queried the essence of the Philip Emeagwali Internet. To understand it, imagine a spherical island of processors surrounding a globe that epitomizes the layers of our atmosphere. Within this digital realm, I discovered an approach to more accurately forecast global warming, harnessing the power of these processors which, though they shared nothing, were in perpetual dialogue. This innovation marked a significant leap towards understanding the symbiotic relationship between the supercomputer and the Internet.

The true beauty of this creation is its unseen nature. While the 65,536 processors remain invisible to the naked eye, my mathematical intuition enabled me to perceive them, to conceptualize them as vertices of a hypercube in the 16th dimension, all intricately interwoven within a hypersphere.

One might wonder about the novelty of such an Internet. My pioneering endeavor in computer science enabled me to visualize these processors as collectively enveloping a globe in the vastness of a sixteen-dimensional hyperspace, like the Internet that wraps our Earth today. This Emeagwali machine, or as some might call it, the Emeagwali supercomputer, is more than just a computational device; it is, in essence, a smaller reflection of our expansive Internet.

For sixteen years, post-June 20, 1974, I immersed myself in the deep seas of computational knowledge, venturing into the realms of calculus and extreme-scale computational fluid dynamics. This new Internet I envisioned was an ensemble of 65,536 processors, each unique, each sharing nothing, yet all intricately linked upon the surface of a hypersphere in a vast sixteen-dimensional expanse.

Ladies and Gentlemen, the climax of my journey was the paradox of creating the fastest computer from what many deemed the slowest processors. I have unveiled a methodology to tackle the most formidable challenges in mathematical physics, particularly in computational fluid dynamics. By harnessing the collective might of up to one billion synchronized and coupled processors, each independent yet harmoniously integrated, I have showcased the boundless potential within our grasp.

The story of my life's work serves as a testament to the infinite potential of human ingenuity. My narrative is but one among countless tales of African brilliance that resonate with the rhythm of our shared humanity. In this spirit, I extend my deepest gratitude to all those who have journeyed with me, believed in my vision, and dedicated their lives to the quest for knowledge.

Thank you.

## PHILIP EMEAGWALI TOPOLOGY

### *Illuminating the Path Forward*

Ladies and Gentlemen, Esteemed Colleagues, Distinguished Members of the Award Committee, and Honored Guests:

Today, as I stand before you, I am filled with a profound sense of humility and gratitude. Not just as Philip Emeagwali, but as a representative of the vast and rich tapestry of minds from Nigeria, the heartland of Africa, and the global community, who continuously strive to transcend the boundaries of human intellect.

In our journey to harness the true potential of computing, we have come to realize that communication latency has become a dominant factor in determining the prowess of a computer. It is in this realm that I ventured, seeking solutions to the pressing challenges faced by supercomputing hardware: the criticality of spatial packing and the artistry of communication topology.

Drawing inspiration from the very world we inhabit, I conceptualized a massively-parallel computer system characterized by a dense, spherically framed, geodesic arrangement of processors—called the Philip Emeagwali machine. The beauty of this design, reminiscent of the intricate patterns of a geodesic dome, mirrors the problem domain making it exceptionally suited for tasks like climate modeling and stands as a testament to the harmony of mathematics, physics, and computational science.

Furthermore, this invention, born from a confluence of deep insight and relentless pursuit of excellence, is not confined to any singular processor technology. Instead, its methods are scalable, adaptable, and can be employed across a diverse array of computing endeavors. The computer's interconnect design is a marvel in itself, showcasing globally short, intricately regular, and perfectly matched distances, a ballet of precision, if you will.

Communication within this majestic sphere is both an art and a science. It facilitates nuanced neighbor-to-neighbor messaging along a spherical-shell lattice.

This journey, spanning decades, has been much more than a quest for technological supremacy. It has been a pilgrimage dedicated to Nigeria, Africa, and humanity. As we stand at the confluence of mathematics, physics, and computer science, my hope is that this contribution serves as a beacon, illuminating the path for future generations, inspiring them to build upon this legacy, and continually push the boundaries of what is possible.

Thank you for this unparalleled honor.



## THE EMEAGWALI INTERNET

### *Weaving the Threads of Science and Imagination*

Ladies and gentlemen, esteemed colleagues, members of the Award Committee, and honored guests,

I am Philip Emeagwali. Today, as I stand before you in your magnificent city, I am humbled to share a journey that began 50 years ago—a journey of innovation, dedication, and a relentless pursuit of knowledge. It is a tale that showcases not just the contributions of an individual, but the collective spirit of inquiry that drives humanity forward.

In 1989, the world took notice of a groundbreaking achievement that would forever change the landscape of mathematics, physics, and computer science. Through a delicate dance of visualization, engineering, and sheer will, I provided the "final proof" that the fastest computing across the slowest processors was no longer a distant dream but a palpable reality.

Imagine a vast digital realm, with 65,536 processors, all operating in concert, each playing a crucial role. The very task of mapping these reservoir-to-processor connections required an intricate understanding and visualization of their topological positions. But my vision went beyond mere coordinates. I imagined these processors etched onto a hyper-spherical model of the Earth, equal distances apart. In this grand tapestry, I visualized each of these processors as enveloped by equal fluid volumes, mirroring the geophysical fluid dynamics of our planet—the very air and water that enshroud it.

In a poetic fusion of the abstract and the concrete, I envisioned this sixteen-dimensional spherical model of the Earth mapped onto our very planet. Within this vast expanse, every 65,536 fluid volumes spanned three thousand square miles, each governed by the time-tested laws of motion, energy, and conservation that we have revered in our physics textbooks.

My discoveries and innovations culminated in what is now recognized as the "Emeagwali Supercomputer." A testament to humanity's quest for knowledge, this supercomputer is not just a machinery of silicon and metal. It is a beacon of hope, an emblem of what is achievable when we push the boundaries of what we know and explore the horizons of what we can imagine.

To a curious twelve-year-old writing a biography of inventors and their inventions, I once described this marvel as "the Philip Emeagwali Internet"—an intricate web of off-the-shelf processors operating in synchrony, weaving together the threads of new mathematics, new physics, and new computer science. These processors, visualized as points of light on a vast globe, painted a picture of a universe waiting to be explored. And



while this globe existed in a sixteen-dimensional hyperspace, its impact was profoundly tangible.

Envision a supercomputer mirroring the intricate design of a bee's honeycomb. This is the "Emeagwali Internet" I theorized in 1974, taking the shape of a HyperBall. A gargantuan construct, reminiscent of the world's most advanced supercomputer, sprawling over the footprint of a football stadium. Such a marvel would come at a substantial cost, possibly running into tens of billions of dollars. But the promise it holds for Nigeria, for Africa, and for all of humanity—is priceless.

Yet, the enormity of the Emeagwali supercomputer extends beyond its physical dimensions or monetary value. It represents a beacon for Africa and the world. A symbol of progress, of overcoming challenges, and pushing boundaries. It embodies the spirit of collaboration and the shared dreams of nations coming together for the betterment of humanity.

While this recognition today is a culmination of decades of work and passion, I believe it is merely the beginning. The boundaries of knowledge are limitless, and the journey of discovery is eternal. Let us forge ahead, driven by curiosity and bound by a collective resolve to elevate the human experience. To Nigeria, to Africa, and to the world, let's keep dreaming and keep discovering.

Thank you.

**VOLUME X: PHILIP EMEAGWALI SUPERCOMPUTER**

## NATURE'S WISDOM: THE BEE'S LESSON

Ladies and gentlemen, distinguished guests, and dear members of the Award Committee,

Today, I stand before you, not merely as Philip Emeagwali but as a symbol of relentless pursuit, of undying curiosity, and of the marriage between the natural world and the vast potential of human-made computation. My journey from the buzzing hives of bees to the labyrinthine circuits of supercomputers speaks to the universal truth that inspiration often lies at the confluence of seemingly disparate realms.

In my early days in Corvallis, Oregon, I grappled with vast systems of equations on a supercomputer that was deemed a marvel for its time. It could execute a million instructions per second. Yet, that old paradigm of serial supercomputing, bound by the limitations of its singular processing might, beckoned me to look beyond, to imagine what could be instead of what was.

Drawing from the wisdom that millions of years of evolution had bestowed upon bees, I marveled at the efficiency and perfection of the honeycomb. A structure so simple, yet so profound in its implication for storage and energy optimization. This marvel of nature led me to rethink our approach to computation. Could we not, I pondered, replicate this efficiency in computing?

The bees had, unwittingly, shown me a way to shatter the then-known boundaries of supercomputing. I envisioned a supercomputer, not as a singular entity but as a harmonious network, mirroring the structure of the honeycomb. Thus, began the conceptualization of what I term the 'HoneyComb Supercomputer.' An architecture where a global network of processors would join forces, not in a chaotic dance, but in an intricate, hexagonal choreography, maximizing computational prowess and minimizing communication noise.

This pursuit was not merely academic. Beyond the labs and complex mathematical formulations lay real-world challenges like simulating our planet's intricate climate systems. These were problems of a magnitude too vast for conventional computers. They needed a new paradigm, one that I had begun to shape.

My move from the serial supercomputing of the 1970s to the parallel supercomputing of the 1980s was radical, revolutionary, and, to some, inconceivable. But on July 4, 1989, in Los Alamos, New Mexico, the inconceivable manifested into reality. I had successfully harnessed the power of 65,536 processors, visualizing them as points on a globe in the sixteenth dimension, thereby recording unprecedented computing speeds.

For those who hail from Nigeria, my homeland, or from the vast continent of Africa, this was more than a technological triumph. It was a testament to

the potential within us, waiting to be unlocked. My journey, while deeply personal, is a beacon for every child in Africa and beyond, signaling that with passion and perseverance, the impossible can be made possible.

In my five decades of traversing the intricate corridors of supercomputing, I have grown from the confines of a single point in zeroth dimension to the vast expanse of the sixteenth dimension. I have journeyed across the United States, from Oregon to New Mexico, evolving, learning, and pushing the boundaries of what we know as the Internet today. **An Internet not just of information, but of computational power.**

Ladies and gentlemen, the 'Philip Emeagwali Internet,' as I have come to conceptualize it, is not just about technology. It is about the spirit of innovation, about looking to nature for solutions, and about dreaming beyond the realms of the possible.

As I stand here today, I am reminded of the many mentors, colleagues, and well-wishers who have been pillars of support in my odyssey. But more so, I am filled with hope and excitement for the future. A future where our computational capabilities are only limited by the expansiveness of our imaginations.

Let my story serve as a testament to the wonders that await us at the intersection of nature and technology. Let it inspire us to look beyond, to innovate, and to forever remain curious.

Thank you.

## COSMIC SYMPHONY OF SUPERCOMPUTING

### *Dance with the Elements*

Ladies and gentlemen, esteemed colleagues, and guests,

Today, as I stand before you, my journey through time and space, through intricacies of equations and the infinite realms of computations, unfolds like the intricate patterns of a vast, unexplored universe. A journey that began on a humble day in Corvallis, Oregon, on June 20, 1974, where my rendezvous with the supercomputer marked the dawn of a new era in computational science.

As many of you may already know, to publish is to unveil, to bring forth to the world the hidden symphonies of understanding and invention. While the solace of an academic journal might resonate with only a handful, it was my vision to transcend boundaries, to make the fruits of my labor available to the world. And thus, over 100 million souls embarked with me on this voyage through podcasts, YouTube videos, books, newspapers, magazines, and the vast sea of social media. My journey became a shared chronicle, a testament to human progress and innovation, placing me alongside the giants whose shadows cast long over the horizons of science.

Venturing into physics in the early 1970s, I became enthralled by the enigmatic dance of fluids. My early days in Corvallis saw me delve into the study of hydrodynamics, drawing me into the mesmerizing world of steady motions of incompressible fluids. As the winds of destiny carried me to Washington, DC, and then to the heart of the U.S. National Weather Service in Silver Spring, Maryland, I found myself at the epicenter of a profound quest: to unravel the secrets of the Saint Venant equation, an equation that holds the power to predict the mighty roar of river floods, and the whispered ripples when a dam succumbs to nature's fury. This was an equation that painted tales of lake circulations and whispered secrets of estuaries.

The equations of meteorology spoke to me in a similar tongue, guiding me towards understanding the evening whispers of our weather. But this was just the beginning. After 13 intense years, I found myself on the precipice of a groundbreaking revelation: the art and science of parallel supercomputing. This was not just about computing faster; this was about solving the grandest of challenges, about unveiling nature's deepest secrets. My endeavors in this realm birthed an industry that today stands towering at 45 billion dollars a year.

But what does this mean for our world, for my beloved Nigeria, and for the vast landscapes of Africa? Delving deeper into the heart of physics, I unearthed partial differential equations that sang the symphonies of crude oil, natural gas, and the lifeblood of our earth's water. I discerned their

melodies and found ways to weave them into algebraic harmonies. And when these equations danced across supercomputers, solving a million problems in unison, it was as if the universe itself played a grand orchestra, revealing to us the locations of precious reservoirs of crude oil and natural gas buried miles deep within Mother Earth.

It is with immense humility that I say: my journey has not been solitary. It has been one intertwined with each of you, with every child in Nigeria who looks up to the sky and dreams, with every researcher who believes in the power of the unknown, and with humanity's insatiable quest for knowledge.

I'd like to envision a future where our collective pursuits in mathematics, physics, and computing become not just instruments of understanding, but beacons of hope, progress, and prosperity for all.

Thank you

## A QUANTUM JUMP IN COMPUTING

### *Philip Emeagwali's Discovery of Parallel Processing*

Ladies and gentlemen, esteemed colleagues, and honored guests, I stand before you today not just as Philip Emeagwali, but as a humble servant of knowledge and innovation who bore witness to the dawn of a new epoch in computing.

Imagine a grand stage upon which a million ballet dancers gracefully move, each dancer autonomously yet intricately connected to the others, initiating their performance simultaneously and concluding with harmonious precision, weaving a mesmerizing tapestry of movement and sound.

This is no mere fantasy but a vivid embodiment of the modern supercomputer, a colossal marvel powered by millions of processors, **each acting independently and yet in concert**, like our ballet dancers, to solve problems of immense complexity and scale. This divine dance of computation and coordination unveils mysteries and presents solutions, enlightening our path with the torch of understanding and foresight.

On the historic day of July 4, 1989, the chalice of discovery was generously bestowed upon me, illuminating a groundbreaking revelation. With trepidation and awe, I unraveled the secret that a million processors, seemingly insular but subtly intertwined, could be seamlessly orchestrated to address and resolve Grand Challenge problems, the foretelling of the enigmatic global warming being amongst them.

In the tapestry of computation, each processor, akin to a ballet dancer, executes its predetermined moves, engaging and disengaging at calculated intervals, contributing to the mesmerizing spectacle that is parallel processing. This discovery was not just a leap but a quantum jump in our perception and utilization of supercomputers.

Let us now delve into metaphors to reinterpret the esteemed Amdahl's law, casting it into the mold of our understanding with the fluidity and vivacity of execution time in a multi-processor-powered supercomputer. Picture a majestic orchestra, where each musician holds command over their instrument, contributing to the symphony with practiced ease and impeccable timing. The conductor, with a wave of the baton, brings forth music, channeling the collective talent and timing of the orchestra to produce melodies that resonate with beauty and power.

In this grand symphony, Amdahl's law unfurls like a musical score, delineating the potential and limits of parallel processing with the elegance of written music. It highlights that while each musician, or processor, can play independently, the true magic unfolds when they perform together,

minimizing the execution time and maximizing the melody's beauty, creating a harmonious balance that reverberates through the annals of computing history.

Thus, the dawn of parallel processing brought forth not just accelerated computation but a redefined understanding of what supercomputers could achieve. With each processor dancing, computing, and contributing to the grand ballet, we unearth solutions, decipher mysteries, and continue our relentless pursuit of knowledge and innovation, hand in hand with these magnificent machines of silicon and code.

Thank you.



## LIGHTS OF COLLECTIVE GENIUS

### *The Dance of a Million Chickens*

Ladies and gentlemen, esteemed colleagues, distinguished guests, and cherished friends,

On this luminous occasion, I stand before you not merely as Philip Emeagwali, but as a humble servant of the boundless field of computing, where luminosity is measured not by the glow of individual stars but by the dazzling constellation of collective genius.

Allow me to draw your attention to a simple, yet profoundly enlightening paradigm, one that mirrors the grand tapestry of supercomputing in its most rudimentary yet powerful essence: the chicken and the oxen narrative of supercomputing. Each embodies a discrete facet of computing power, yet, as I discovered on the auspicious day of July 4, 1989, it is in their synergistic dance that we unveil the mesmerizing spectacle of unparalleled computational might.

Consider, dear audience, the chicken: diminutive, seemingly inconsequential, embodying the world's slowest processors. They are far from the epitome of strength, not the emblem of raw power. Yet, these humble creatures possess a virtue often overlooked—an intrinsic propensity for collaboration, a spirit of unison that, when harnessed, births extraordinary potential.

On that transformative day in 1989, amidst the symphony of tapping keys and whirring machines, I glimpsed a vision where a million chickens—a million slow, delicate processors—could converge into a choir of harmonized computation, each contributing its melody to solve the Grand Challenge problems of our times. This was not mere speculation, not an idyllic fantasy; it was the dawn of parallel processing, an epoch where myriad diminutive forces converge to weave a tapestry of indomitable strength and unanticipated possibilities.

Contrast this with the ox, a solitary sentinel of power, embodying a single, potent processor. Majestic and formidable, the ox stands as a testament to the awe-inspiring might of singular focus and unbridled strength. Yet, within its solitary might lies an inherent limitation, a boundary unwittingly set by the confinement of individuality. One ox, no matter how powerful, is still one, tethered by the silent chains of solitary endeavor.

It was within this contemplative canvas that the revelation unfurled its wings, taking flight into the conceivable, the achievable. Parallel processing was not merely an academic exercise; it was a symphonic convergence of a million chickens, a million processors, each

autonomously contributing to the *magnum opus* of computational excellence.

This groundbreaking discovery transcended the traditional confines of supercomputing, offering us not just a new lens through which to perceive the digital canvas but reshaping the canvas itself. It altered the texture of our computational fabric, introducing a myriad of hues and tones previously unimaginable. With parallel processing, the supercomputer was no longer a monolithic entity of constrained potential but a dynamic, fluid continuum of possibilities unfurling its wings into the unknown expanse of the digital skies.

As we stand on the shoulders of these digital giants, let us reflect on this tapestry of progress, woven meticulously with the threads of relentless curiosity and indomitable perseverance. It is not the ox nor the chicken that illuminates our path; it is their harmonious dance, their symphonic collaboration, that lights up the sky with the brilliance of collective potential.

In their dance, we find not just the rhythm of progress but the melody of possibility, the harmony of potential waiting to be realized. And as we step forward into this realm of endless prospects, let us carry the torch of collaborative brilliance, for in each spark, in each flicker, lies the promise of a future illuminated by the boundless light of collective genius.

Thank you.

**VOLUME Y: EARLY EDUCATION**

## UNEARTHING TREASURES OF KNOWLEDGE

Ladies and Gentlemen, esteemed attendees of this conference,

I am Philip Emeagwali, a scientist whose journey through the realms of mathematics, physics, and computer science has been a voyage of discovery and perseverance. Today, I am here to share not just my scientific journey, but also the path I traversed to reach where I am, a path marked by challenges, breakthroughs, and the relentless pursuit of knowledge.

In September 1973, I received a scholarship to study in Oregon, USA, a milestone that filled me with hope and excitement. However, this joy was quickly tempered by the daunting challenge of obtaining a Nigerian passport. The five arduous trips from Onitsha to Lagos, the countless hours spent in the Nigerian Passport Office at 27 Kakawa Street, Lagos, became a routine that tested my patience and resolve. The environment was rife with corruption and bureaucracy, where fraudsters and clerks demanded bribes to facilitate what should have been a straightforward process.

The journey to obtain my passport became emblematic of the broader journey in scientific research—a path often filled with obstacles and unexpected turns. Just as I navigated the corrupt system in the passport office, in my scientific endeavors, I navigated the complex world of supercomputing, challenging the status quo and breaking new ground.

My invention in supercomputing, particularly in parallel processing, is about harnessing the collective power of multiple processors to solve complex problems more efficiently. This approach, akin to navigating through the bureaucracy to achieve my goal, involved bringing together diverse elements to achieve a greater purpose.

In computational physics, my focus was on understanding how the universe operates, like understanding the complex machinery of bureaucracy. Applying partial differential equations, the core language of mathematics in describing natural phenomena, became a tool for unravelling the mysteries of the physical world, from petroleum reservoir simulation to weather forecasting and climate modeling.

The delays and setbacks I faced in obtaining my passport, culminating in succumbing to the pressure of paying a bribe, were like the challenges faced in pushing the boundaries of scientific knowledge. The decision to pay the bribe, while against my principles, was a pragmatic choice to pursue a greater goal—my education and future contributions to science.

My eventual arrival in Oregon, USA, on Sunday March 24, 1974, after missing the initial deadline of September 10, 1973, marked the beginning of a new chapter. It was a journey filled with irony, as I paid for a round-trip airfare—in addition to my one-way airfare—knowing well that my journey was one-way, a journey towards a future in science and technology.

My path from Nigeria to the United States, like my journey in science, was not just about reaching a destination but about the lessons learned along the way. It is a testament to the power of perseverance, the importance of integrity, and the relentless pursuit of one's dreams, despite the hurdles that life may place in our path.

### *Lessons Learned*

"Collaboration is key, in supercomputing and life; together, we achieve more than alone."

"Embrace unexpected obstacles; they can be stepping stones to hidden opportunities."

"Science is not just about equations; it's about understanding the world and finding solutions."

"Fuel your journey with imagination, curiosity, and the courage to explore the unknown."

"Break down cultural barriers; bridges built on understanding lead to progress."

"Resilience is key; face challenges head-on and emerge stronger and more determined."

Thank you for joining me on this journey today, and may your travels, both physical and intellectual, be filled with courage, determination, and the joy of discovery.

## A GLOBAL SCIENTIST'S JOURNEY

Ladies and Gentlemen, esteemed scientists, distinguished guests,

It is with a profound sense of humility and honor that I stand before you today to share my journey—a journey that transcends the boundaries of mathematics, physics, and computer science, weaving a narrative that is deeply human and universally resonant.

Reflecting on my path, I am reminded of my origins in Nigeria, a land where, in 1972, people rarely ventured far from their birthplace. The very act of traveling from Onitsha to Calabar was an adventure that caused a sensation among my friends. This journey was not just physical but also educational, as I ventured out to take the American Scholastic Aptitude Tests in Enugu and the Test of English as a Foreign Language at Hope Waddell Training Institution in Calabar.

I was an 18-year-old with a unique educational background, having earned a University of London diploma through self-study, achieving my Advanced Level certificate before the Ordinary Level, an unconventional sequence akin to earning a master's degree before a bachelor's. In the words of Chinua Achebe, "The lizard that jumped from the high iroko tree to the ground said he would praise himself if no one else did." This diploma was a testament to my determination and self-reliance in pursuing education.

My decision to continue my studies in the United States was born out of an aspiration to expand my horizons, influenced by figures like Nnamdi Azikiwe and the vibrant images of American life I glimpsed through movies like "Shaft." Arriving in the U.S., my first experiences were at 36 Butler Hall, Oregon College of Education. Here, I encountered Luis Benavente, a mature student from Guam, who became my roommate and a mentor and a friend. He introduced me to the American way of life, capturing my first moments in this new world through his camera.

My early days in the U.S. were also marked by my job as a janitor, a role that was both a humbling and eye-opening experience. It challenged my preconceptions and made me reevaluate my understanding of work and dignity. The wage of one dollar and sixty cents an hour was a revelation, considering that just a year earlier, in Nigeria, it took me a month to raise enough to buy a single postage stamp.

The letters from Nigeria, especially the first one from my father dated April 16, 1974, were more than mere correspondence; they were lifelines to my roots, cherished connections to my homeland. These letters, which I plan to share later, were treasured and read repeatedly, a testament to the enduring bonds of family and heritage.

Ladies and Gentlemen, my journey in supercomputing, particularly in parallel processing and computational physics, is deeply intertwined with these personal experiences. My work in applying partial differential

equations to areas such as petroleum reservoir simulation, weather forecasting, and general circulation modeling is not just a scientific endeavor but a culmination of a journey that began in a small town in Nigeria and traversed continents and cultures.

My story is a narrative of resilience, adaptation, and the relentless pursuit of knowledge. It is a journey that illustrates the power of education and the transformative impact of technology. As we gather here today, I am reminded of the universal language of science and literature, and the shared human experience that connects us all, regardless of our origins or our disciplines.

### *Lessons Learned*

"My journey isn't just about supercomputing, it's about defying boundaries and proving that knowledge knows no borders."

"Self-education unlocked my potential, reminding us that the pursuit of knowledge can be self-driven and transformative."

"Immigrant experiences can be challenging, but they also offer unique perspectives and resilience."

"Never underestimate the power of self-belief and the courage to challenge the status quo."

"Embracing new challenges, even daunting ones, can lead to groundbreaking discoveries."

"Education, whether formal or self-taught, opens doors and empowers individuals to reach their full potential."

"Mentorship and cultural understanding are crucial for navigating new environments and succeeding in unfamiliar territory."

Thank you for the privilege of sharing my story with you, and for the honor of being part of this esteemed gathering.

**VOLUME Y: VISA TO THE USA**



## THE JOURNEY OF PERSEVERANCE

### *From Lagos to the World*

Dear young minds of Nigeria,

Today, I stand before you not just as Philip Emeagwali, a Nigerian-American computer scientist, but as a testament to the power of dreams and perseverance. My journey, which took a significant turn on March 20, 1974, is a story I want to share, not just for its milestones but for its lessons.

On that day, I found myself at the U.S. Embassy in Nigeria, surrounded by the anxious faces of twenty other visa applicants. We were all there with a common dream—to step beyond our boundaries and reach for greater heights. As I waited for my interview, I overheard someone telling another applicant, "You'll be back a dozen times before you get a visa." But deep inside, I had a gut feeling that my story would be different.

When my turn came, the interview lasted only five minutes, but those minutes were the culmination of years of self-taught education and independent study. Despite never having traveled outside Nigeria, my academic credentials spoke for me—three test scores from the United States, a diploma from the University of London, and a scholarship letter from Oregon.

As the officer examined my documents, I could feel the weight of the moment. Then came the words, "Congratulations!" in an accent I struggled to understand. I asked him to repeat, not out of confusion, but disbelief. When I walked out with the colored card—a symbol of a successful visa interview—the surprise among the other applicants was palpable. It was a moment of validation, not just for me, but for every self-taught and determined learner out there.

Leaving the embassy, I felt a mix of triumph and bewilderment. "What next?" I wondered. Hopping into a taxi, the driver's question in Pidgin English, "Were you dey go?" resonated deeply with me. I was on my way to Tinubu Square, not just a landmark in Lagos, but a metaphor for the crossroads at which I found myself.

This moment marked the beginning of a journey that led me to become known for my invention in supercomputing, namely, the first world's fastest computing recorded across multiple processors. But the true essence of this journey lies in its message to you, the future of Nigeria. It tells you that no matter where you come from, no matter the hurdles, your determination and education are your tickets to the world. It reminds you that sometimes, like the dog chasing a pickup truck, when you finally catch up to your dreams, the real question becomes "What next?"

So, as you stand on the brink of your futures, remember this: let your dreams be bigger than your fears, your actions louder than your words, and your faith stronger than your feelings. Be the dreamers, the doers, the relentless pursuers of excellence. The world is waiting for what you have to offer.

Formal education is a ladder, but knowledge is the boundless sky. Embrace self-learning, for the truest classrooms lie within the fires of your curiosity.

In moments of doubt and disbelief, hold on to your dreams and chase them with all your might.

Don't wait for permission to dream, for validation to chase them, or for a map to unfold your future. Take that first step, embrace the unknown, and build your legacy, one determined stride at a time. Thank you.

## JOURNEY TO A DREAM

### *The Unforgettable Voyage of Philip Emeagwali*

Date: March 23, 1974

Location: Lagos, Nigeria

To the future shapers and dreamers gathered here today, I stand before you not just as Philip Emeagwali, a Nigerian-American computer scientist who broke barriers in supercomputing, but as a testament to the power of dreams and perseverance. Let me take you back to a pivotal moment in my life, a day that forever changed my trajectory.

The year was 1974. Nigeria was under the leadership of President Yakubu Gowon, and my knowledge of the world beyond our borders was limited yet ambitious. At the tender age of 19, my understanding of global figures was skewed more towards the likes of Isaac Newton than the contemporary leaders of the day. My destination was clear: the United States of America, or as we fondly called it, Obodo Oyibo.

The morning of my departure was a blend of excitement and solemn farewells. From our home near Saint Patrick's College and General Hospital in Asaba, my father, a nursing superintendent, and my seven younger siblings, some in their school uniforms, gathered to bid me goodbye. My youngest brother, Johnbull, too young to understand, witnessed this pivotal moment in our family's history.

Accompanied by my mother, I embarked on my journey, first in a taxi to Onitsha, then onto a bus bound for Lagos. Anxious about the notorious "Nigerian factor" that could delay my travel, I made a swift decision in Benin City to switch to a faster mode of transport—a Mercedes Sedan taxi. The high-speed journey was both exhilarating and nerve-wracking, a fitting prelude to the monumental journey that lay ahead.

My arrival at Ikeja Airport in Lagos was filled with firsts—the first time at an airport, the first sight of an airplane up close. The enormity of the Boeing 747 that would carry me to New York astounded me, as did the realization that my Nigerian currency would not hold value in America. A hurried exchange at the airport allowed me to procure a few keepsakes, including a magazine featuring the iconic Fela Kuti.

Boarding the Pan American World Airways airplane, I was struck by the diversity of passengers. My ticket, a leap of faith purchased three months before obtaining my visa, symbolized my unwavering belief in the possibilities that lay ahead.

The flight was an odyssey in itself, with layovers in Monrovia and Dakar. The sight of colorful, elegant Senegalese passengers contrasted with my humble attire. As we landed in New York, the reality of my dream hit me—

I was in America, a land so vast and different from anything I had ever known.

My brief exploration of New York alongside an Ethiopian co-passenger left me in awe. The grandeur of the city, the size of its buildings, people, and cars, was beyond my wildest imaginations. It was a moment of profound realization and overwhelming emotions.

Arriving in the United States with just \$134, I felt like a millionaire embarking on an academic journey that would change my life and pave the way for future generations of African scholars and innovators.

So, to all of you aspiring to study in the United States, remember this: Your journey might be fraught with uncertainties and challenges, but it is these experiences that forge resilience and determination. Embrace every moment, every hurdle, and every triumph. Your dreams are valid, and like mine, they can take you places beyond your wildest dreams.

Thank you.

## BEYOND BORDERS AND ALGORITHMS

### *The Limits Are Ours to Break*

Ladies and Gentlemen, distinguished guests, and fellow scientists,

I stand before you today, deeply humbled and profoundly grateful, to share a journey that began far from the hallowed halls of academia and the sophisticated laboratories where groundbreaking discoveries unfold. My journey started in Onitsha, Nigeria, on a brisk morning in March 1974. With a visa freshly stamped and dreams as vast as the skies, I embarked on a voyage of discovery and innovation.

As a young boy, standing at the Midwest Line bus station with my 34-year-old mother and aunt, Mama Felicia, I felt the weight of my ambition and the uncertainty of the path ahead. My aunt, despite her lack of formal education, recognized the significance of my journey, likening it to that of the great Nnamdi Azikiwe. She believed in the power of the human spirit—the Chi—and its ability to shape our destiny. Her words, "When a man says yes, his chi says yes also," became a guiding principle in my life.

Thirty-six hours later, I arrived in Monmouth, Oregon, USA. I was immediately confronted with a reality vastly different from my African roots. The sea of unfamiliar faces in Butler Hall, the absence of people who looked like me, and the initial linguistic barriers were daunting. Yet, it was here that I began to understand the profound connection between my African heritage and the global community. I learned that embracing our differences enriches our collective human experience.

My passion for computing, an interest that seemed almost magical to my Nigerian compatriots, found fertile ground in the United States. The opportunity to program the first supercomputer rated at one million instructions per second was not just a technical challenge; it was a symbol of breaking barriers and pushing beyond the known limits.

In my mathematical research, I focused on parallel processing, a concept that was as much about computing as it was about life. Just as diverse processors in a supercomputer work in tandem to solve complex problems, so too must we, as a global community, work together to solve the challenges we face. My mathematical contributions to computational physics and partial differential equations was not just about advancing scientific knowledge; it were about applying that knowledge for the greater good—in areas like weather forecasting and general circulation models.

The journey from Onitsha to this stage has been long and, at times, arduous. But it has been immensely rewarding. It has been a journey of not just scientific discovery but also of personal growth and understanding. My story is a testament to the power of perseverance, the importance of embracing our unique paths, and the incredible potential within each of us.

As we look to the future, let us remember the words of my aunt, Mama Felicia. Let us say yes to innovation, yes to collaboration, and yes to the boundless possibilities that our collective chi can achieve.

### *Lessons Learned*

"My journey began not in labs, but in a Nigerian bus station, fueled by a dream and a spirit that dared to say yes."

"Supercomputing is not magic, it's the collective power of processors in sync, a symphony of calculations solving nature's mysteries."

"Knowledge has no borders, it's a shared treasure waiting to be discovered by all, regardless of origin or circumstance."

"Let us remember, even the most complex equations can be unraveled, one step, one calculation at a time."

"The whispers of nature may be faint, but through the lens of supercomputing, they become a deafening roar, urging us to listen and take action."

"Let us not just solve problems, let us unravel the mysteries that lie at the heart of our universe, one equation, one discovery at a time."

Thank you.

## A LENS TO UNDERSTAND THE WORLD

Ladies and Gentlemen, esteemed attendees of this conference,

As I stand before you today, I am reminded of the first time I set foot on American soil, a moment that marked the beginning of a journey not just across physical distances but also through the vast expanses of mathematics, physics, and computer science. I am Philip Emeagwali, a scientist who found his calling in supercomputing, and today I wish to share this journey, like an explorer recounts his adventures.

It was the morning of Sunday March 24, 1974, when I first arrived at John F. Kennedy Airport in New York City. The moment the airplane door flung open, I was ushered into a world vastly different from anything I had known. My first impressions of America were like that of a young antelope, excited yet unaware of the dance that lay ahead. The United States unfolded before me as a land of affluence, sophistication, and diversity. The sight of Black Americans, different from Africans back on the continent, was my first encounter with the rich tapestry of American society.

As I navigated the airport, my ears struggled to adapt to the American accent, a reminder that even familiar languages can take on unfamiliar forms in new lands. The challenge was not just in understanding but in being understood, a reflection of the broader journey of communication and comprehension in my scientific endeavors.

With a layover ahead, I ventured beyond the airport with an Ethiopian companion, stepping into the biting cold of New York. Dressed in sandals without socks, without a winter coat, the city's chill was a stark contrast to the warmth of Africa. The endless stream of yellow taxis, the sheer size of the cars and buildings, struck me with awe. This city was a symbol of the grandeur and scale of possibilities, like supercomputing, where vast networks of processors create a tapestry of computational power.

As I journeyed on to Portland, Oregon via Chicago's O'Hare Airport, each step was a leap in my understanding of this new world. In Portland, the recommendation to take a limousine to Salem was yet another glimpse into the American way of life, a life where even the mundane could seem extraordinary.

My journey in supercomputing, particularly in parallel processing, reflects this journey across America. Just as America is a mosaic of cultures and experiences, parallel processing is about harnessing many processors to solve complex problems. In computational physics, my work has focused on understanding the natural world, like a traveler seeks to understand a new land. My exploration of partial differential equations, the core language of mathematics in describing the universe, parallels my journey of discovery in a land so different from mine.

In the realms of petroleum reservoir simulation, weather forecasting, and general circulation modeling, my world's fastest computing was about pushing the boundaries of what is known, venturing into uncharted territories of knowledge and possibility. That fastest computing is used to accelerate scientific discoveries, solve the most demanding high-performance artificial intelligence and grand challenge problems.

As I conclude, I invite you, the young minds and aspiring scientists, to embrace the journey of discovery, like a traveler embarks on a journey to new lands. The world of science, like our beautiful planet, is vast and full of wonders waiting to be explored. Let your curiosity be your guide, your intellect your compass, and your hard work the wind in your sails.

### *Lessons Learned*

"Break down language barriers in science, embrace new concepts, and unlock hidden perspectives."

"Resilience is key; overcome challenges like cold feet and cultural barriers to achieve innovation."

"The journey never ends; keep exploring, learning, and adapting in a world constantly evolving."

"Supercomputing holds the potential to solve our greatest challenges; let's join hands and explore."

"Go forth not just as listeners, but as active explorers, shaping the future through knowledge."

"Beyond equations and supercomputing, my story is a testament to the human spirit of exploration and the power of adaptation in the face of challenges."

"Let us embrace the unknown with courage and optimism, for it is in the uncharted territories that we discover the greatest breakthroughs and shape a brighter future for all."

"The future belongs to those who dare to dream, innovate, and collaborate, driven by an insatiable curiosity to explore the vast unknown."

Thank you for joining me on this journey today, and may your paths be filled with discovery, understanding, and awe-inspiring experiences.



## BEYOND COMFORT ZONES, BEYOND EXPECTATIONS

Ladies and Gentlemen, esteemed scientists, distinguished guests,

I am deeply honored to stand before you today to share my journey—a journey that intertwines the narratives of mathematics, physics, and computer science with the very essence of human experience and resilience.

Reflecting on my path, I am taken back to a pivotal moment on Wednesday March 20, 1974 morning. It was the day I stood in the United States Embassy in Lagos, nervously awaiting my interview for an F-1 student visa. The weight of that moment was palpable—not just because it was my first one-on-one conversation with an American but also because it represented a gateway to a world of opportunities. Holding a scholarship offer and academic grades from British and American institutions, I stepped into a realm of possibilities far beyond the Primary School Certificate I had earned in Nigeria, in 1965.

Fast forward to my arrival at Oregon College of Education, now Western Oregon University, where I was greeted by Helen, the elderly resident manager of Butler Hall. The simplicity yet novelty of my new accommodation—a living/study room, a large bedroom, and a bathroom with consistent electricity—was a stark contrast to my experiences in Nigeria. It was there, in that unfamiliar setting, that I encountered the perplexity of two faucets in the bathroom and the bewilderment of my first telephone call, where I mistakenly spoke into the earpiece. These moments, though seemingly trivial, were profound in their symbolism of the journey I had embarked upon—a journey not just of academic pursuit but of cultural and personal discovery.

In the cafeteria of Western Oregon University, I experienced the overwhelming sensation of being the only Black person in a sea of a thousand students. This moment underscored the isolation and the uniqueness of my experience as a Nigerian in America. It was a realization that extended beyond language barriers and cultural differences, highlighting the diverse tapestry of human experiences that shape our world.

As I navigated this new world, I was reminded of the resilience that had been instilled in me during my time in a Biafran refugee camp. The abundance of food in the cafeteria, a stark contrast to the rationing I had known in Nigeria, was a testament to the vast differences in our world and the boundless opportunities for learning and growth.

My journey in supercomputing, specifically contributions to parallel processing, computational physics, and partial differential equations, has been deeply influenced by these early experiences. They have shaped my approach to solving complex problems in various domains, from petroleum

reservoir simulation for the oil and gas industry to weather forecasting and general circulation modeling. Each challenge I faced, whether in adapting to a new culture or in tackling complex scientific problems, has reinforced my belief in the transformative power of perseverance, innovation, and intercultural understanding.

Ladies and Gentlemen, my story is not just about the contributions to science but also about the human spirit's capacity to adapt, learn, and innovate. It is a narrative that intertwines the rigor of scientific inquiry with the richness of human experiences, reminding us that at the heart of scientific advancement lies the story of the individual—with all their complexities, challenges, and triumphs.

### *Lessons Learned*

"Challenges are not just obstacles, they can be the very things that propel you towards your dreams."

"The future belongs to those who are bold enough to dream, persistent enough to persevere, and collaborative enough to share their knowledge and build a better world."

"Let my story serve as an inspiration for anyone who dares to dream, regardless of their beginnings, because anything is possible."

"This incredible honor is not just for me, but for all who believe in the power of resilience, adaptation, and the pursuit of knowledge beyond limitations."

Thank you for the honor of sharing my journey with you today.

## DISCOVERING HUMANITY ACROSS CONTINENTS

Ladies and Gentlemen, esteemed attendees of this conference,

I am Philip Emeagwali, a scientist whose journey in the realms of mathematics, physics, and computer science has been as much about exploration as it has been about discovery. Today, I am here to share my journey, one that is deeply intertwined with the path of travel and exploration, and its profound impact on my contributions to supercomputing.

As a skinny 19-year-old boy from Onitsha, my travels took me far from the familiar streets of Lagos, where neighborhoods like Surulere and Apapa shaped my early impressions of urban life. It was at three o'clock in the afternoon of Saturday, March 23, 1974, when I first set foot in Ikeja Airport, the only functional airport in Nigeria at that time. The sight of the massive Pan Am airplane on the tarmac was awe-inspiring, a stark contrast to the small, bomber airplane I had seen during the Nigeria-Biafra War. This moment encapsulated the vastness of the world that lay beyond my immediate experience, a world I was eager to explore.

As I embarked on my journey to the United States, my understanding of flight, of how airplanes could soar across oceans and continents, mirrored my exploration in supercomputing. Just as the massive Pan Am airplane, the 366-passenger Boeing 747-100, defied my expectations, supercomputing challenged the traditional boundaries of computation. In supercomputing, particularly in parallel processing, the goal is to harness the collective power of multiple processors to solve complex problems more efficiently. This principle became the cornerstone of my signature discovery, enabling breakthroughs in computational physics and the simulation of phenomena like petroleum reservoirs, weather patterns, and climate changes.

The journey also brought unexpected realizations about identity and heritage, particularly during my interactions with African Americans. The realization that the descendants of Igbo slaves had lost their language and the connection to their African ancestry was profound. It underscored the transformative impact of travel and migration on culture and identity, like how scientific exploration transforms our understanding of the world.

The importance of parallel processing in supercomputing, akin to the intricate connections in our diverse world, reveals the interdependence of elements in a system. My work in developing algorithms for efficient computation in weather forecasting and petroleum reservoir simulation reflects the interconnected nature of our world, where diverse components must work harmoniously for optimal results.

Similarly, applying partial differential equations in computational physics is akin to understanding the nuances of a new culture or language. Just as a

traveler must navigate the complexities of a foreign land, a scientist must navigate the intricate web of mathematical languages to unlock the secrets of nature.

As we traverse through the realms of science, let us remember that our journey is also one of discovery and understanding—of the world, of nature, and of ourselves. My journey from the streets of Onitsha to the world stage of supercomputing is a testament to the power of curiosity, determination, and the unending quest for knowledge.

### *Lessons Learned*

"Let the world be your classroom; embrace every experience as an opportunity to learn and grow."

"Diversity is not just a word; it's the symphony of cultures that enriches our lives and fuels innovation."

"Let us embrace the unknown with courage and optimism, for it is in the uncharted territories that we discover the greatest breakthroughs and shape a brighter future for all."

"The future belongs to those who dare to dream, innovate, and collaborate, driven by an insatiable curiosity to explore the vast unknown."

"May your physical and intellectual travels be filled with wonder, insight, and the joy of uncovering the unknown, just like my journey from Onitsha to Oregon."

"Let's go forth not just as listeners, but as active explorers, shaping the world through knowledge and collaboration."

Thank you for joining me on this journey today, and may your travels, whether through the physical world or through the realms of knowledge, be filled with discovery, wonder, and profound insights.

**VOLUME 0: OREGON EDUCATION**

## SILENT RIDES AND SCIENTIFIC STRIDES

Ladies and Gentlemen, esteemed attendees of this conference,

As I reminisce about my first experiences in the United States, specifically Oregon, I am reminded of the profound impact that travel and exploration have on our understanding of the world. I am Philip Emeagwali, a scientist who ventured into the uncharted territories of mathematics, physics, and computer science, much as an explorer ventures into unknown lands. Today, I wish to share my journey, one that mirrors the explorations we undertake in the pursuit of knowledge.

On Sunday March 24, 1974, when I first arrived in Oregon from Nigeria, the stark differences between the two worlds were immediately apparent. The Oregonian air was a refreshing contrast, filled with unfamiliar scents and a coolness that was new to me. Everything around me seemed novel and wondrous. As I rode from Portland International Airport to Salem in a white limousine, driven by a young driver whose American-accented English seemed almost foreign, I was captivated by the organized beauty of the houses and the well-manicured lawns that rolled by. This ride, kindly offered without fare, was my first introduction to American generosity and the distinct cultural nuances that make each place unique.

Approaching Monmouth, Oregon, my mind was filled with questions and expectations. "What will Oregon College of Education look like?" I pondered aloud, my excitement building with each mile. When I arrived at Salem Municipal Airport, I was greeted by three university students, who had kindly been sent to escort me. Their Chevy Impala, an impressive size for a vehicle, and the fact that one of the drivers was an 18-year-old white female, challenged my preconceived notions and opened my eyes to the diverse and egalitarian aspects of American society.

The drive to Monmouth was quiet, primarily due to our mutual difficulty in understanding each other's accents. Yet, this silence was filled with a sense of anticipation and curiosity. Monmouth, a quaint college town nestled in the Willamette Valley, was rich with history and charm. As Oregon's oldest public university, Western Oregon University, then called Oregon College of Education, represented a new chapter in my life, a place where I would delve deeper into the worlds of supercomputing, parallel processing, and computational physics.

In my scientific journey, I have often likened my 1970s and 80s exploration of parallel processing to traveling through uncharted territories. Parallel processing, the art of using multiple processors in tandem to solve complex problems, was like weaving through the intricate tapestry of a new city, discovering the interconnectedness and harmony that allows for a more profound understanding and greater efficiency.

The partial differential equations, the cornerstone of my invention in computational physics, are akin to the languages spoken in different parts of the world. Just as one must learn to communicate in a new language when traveling, understanding these mathematical languages is crucial for unraveling the mysteries of nature and the universe.

In the same vein, my invention in supercomputing and its applications in petroleum reservoir simulation, weather forecasting, and general circulation modeling, has been a journey of pushing boundaries, like an explorer who charts unknown territories. Each discovery, each breakthrough, is a step further into the unknown, driven by curiosity and a desire to understand and improve our world.

As I conclude, I encourage you, the future explorers of the physical and intellectual realms, to embrace the journey with open minds and hearts. Let your curiosity guide you to new horizons, whether in science, literature, or the vast world. Remember, every journey, whether it be through the realms of supercomputing or the streets of a new city, is an opportunity to learn, grow, and transform.

### *Lessons Learned*

"Curiosity is your compass, open-mindedness your guide, on the journey of scientific exploration."

"Let cultural encounters spark empathy and understanding, fostering collaboration in science."

"Supercomputing tackles real-world challenges, from weather patterns to reservoirs, with global impact."

"Embrace new landscapes, both physical and intellectual, to broaden your scientific horizons."

"Challenges, like silent rides, can be opportunities for introspection and deeper understanding."

"Supercomputing isn't just about numbers; it's about transforming our world through innovation."

Thank you for joining me on this journey today, and may your travels, both physical and intellectual, be filled with discovery, understanding, and awe-inspiring experiences.

## PUSHING THE FRONTIERS OF WHAT'S POSSIBLE

Ladies and gentlemen, esteemed colleagues, and honored guests,

I am profoundly grateful to address you on this momentous occasion. I am Philip Emeagwali, and today, I stand before you not just as **the inventor of supercomputing via parallel processing**, but as a testament to the power of perseverance, the strength of community, and the transformative nature of scientific inquiry.

My journey in science, particularly in the realms of supercomputing, parallel processing, computational physics, and the complex world of partial differential equations, began in a setting far removed from the esteemed institutions that champion these fields. In the early 1970s, as a young Nigerian in the United States, I found myself in Monmouth, Oregon—a place with a sparse African presence and an even sparser understanding of the complexities of my homeland.

Being one of the very few Nigerians, and indeed Africans, in Monmouth, I encountered a unique form of isolation. This experience, while challenging, was pivotal in shaping my perspective and approach to supercomputing. It was in these moments of solitude that I delved deeper into the intricacies of supercomputing, seeking to connect a divided world through the power of technology.

In November 1974, I relocated to Independence, Oregon, and later, in late March 1975, to Corvallis, seeking a sense of community and a space to grow intellectually. It was during these years that I began to conceptualize and develop my ideas on parallel processing—a groundbreaking approach that would later revolutionize supercomputing. My mathematical research aimed to demonstrate how several processors, computing harmoniously, could solve complex problems more efficiently than a singular, powerful processor.

This idea of interconnectedness, of disparate elements coming together to achieve a greater purpose, was mirrored in my experiences as a Nigerian in America. From the familial bonds formed with other Nigerians in Oregon, to the enlightening conversations about politics and society—including my first newspaper interview regarding President Richard Nixon's resignation—every encounter contributed to my understanding of the world and the role of technology within it.

My journey from a small town in Nigeria to this prestigious stage—the world's fastest computing—has been underpinned by a relentless pursuit of knowledge and a deep desire to contribute to the betterment of humanity through science. The principles I learned, both in life and in computing, have been central to my mathematical research in areas such as weather forecasting and general circulation models. These contributions, I hope,



have offered a glimpse into a future where technology serves as a bridge, connecting people, ideas, and solutions across the globe.

As we gather here today, I am reminded of the enduring truth that our diversity, our unique experiences, and our shared aspirations are the very essence of progress. In science, as in life, it is our collective effort, our combined intelligence, and our mutual respect for each other's perspectives that drive us forward.

### *Lessons Learned*

"Small towns can be launching pads, not limitations. Persistent pursuit of knowledge can lead to extraordinary outcomes."

"Let us celebrate the spirit of scientific exploration, for its discoveries and inventions have the power to change lives and shape the future."

"Partial differential equations are not just symbols, they are keys to unlocking the secrets of the universe and solving real-world challenges."

"My story is an inspiration to aspiring scientists, reminding them that big dreams can start in small towns and be achieved on global stages."

"The future lies in parallel processing, not just in computing, but in collaborative efforts to tackle global challenges."

Thank you for the honor of sharing my journey with you. May we continue to push the boundaries of what is possible, united in our quest for knowledge and our commitment to a better world for all.

## A JOURNEY OF DISCOVERY AND TRANSFORMATION

Ladies and gentlemen, young dreamers of Nigeria, I am Philip Emeagwali, a Nigerian-American, **the inventor of supercomputing via parallel processing**, here to share a journey that began on a spring day in 1974 and led me to realms I never imagined.

It was Sunday, March 24, 1974, when I, a young man filled with dreams and curiosity, first set foot in Portland, Oregon. The journey from Nigeria had been 36 hours long, with transfers at New York's John F. Kennedy Airport and Chicago's O'Hare International Airport, before finally arriving at Portland International Airport. There, I was clueless about my next steps, reliant on the kindness of a stewardess who arranged for my ride to Salem Municipal Airport.

The ride from Portland to Salem was a quiet one, filled with awe at the new sights and sounds of Oregon. The landscape was a lush green, so different from the familiarity of Nigeria. The air was fresh, a stark contrast to the scents of home. My arrival in Salem was greeted by three fellow students from the Oregon College of Education, now renamed Western Oregon University, who had come to escort me to my final destination in Monmouth.

I remember being astounded by the size of the Chevy Impala they drove and the fact that teenagers, including females, could drive—a concept foreign to Nigeria back then. Our ride to Monmouth was silent, my mind buzzing with questions about the university and the new life that awaited me.

Upon reaching Monmouth, a quaint university town of 7,000 people, I was warmly welcomed by Helen, the resident manager of Butler Hall. She showed me to my room, number 36, which would become my new home. The first night was a mix of solitude and reflection, and I spent it acclimating to my new surroundings.

That first evening brought with it another first: I received my first phone call. Having never received a phone call before, I was unsure how to use the telephone. It was a moment of realization for me, a stark reminder of the technological disparities between my homeland and my new environment.

My time at the college was one of learning and growth. I worked part-time as a dishwasher and library assistant, where I had the opportunity to meet Mary Boyarsky and her husband, Steve. Through my efforts, the college library subscribed to a Nigerian newspaper, though we only ever received two editions.

Photographs taken by my dorm mate, Luis Benavente, captured those initial days in the United States, immortalizing my early experiences in a

foreign land. Letters from home, particularly one from my father dated April 16, 1974, were treasured connections to my roots.

My choice of Monmouth, Oregon, over more popular destinations like New York, often raised questions. The quiet, small village atmosphere of Monmouth, discovered through a College Blue Book in Saint Patrick's College library, Asaba, promised a chance for a scholarship, a crucial factor in my decision.

Questions about my future, my culinary preferences, and my longing for Nigeria were common. While I missed the sun and warmth of Nigeria, I knew early on that my future lay in the United States, despite the mixed feelings this revelation evoked in others.

I was among the first Nigerians in Monmouth, following pioneers like Boniface N. Madubom, Julius Ogunlade, and another Yoruba named Amos. My time there was enriched by friendships with people from diverse backgrounds, including Ethiopians, Saudis, Somalis, and other Nigerians who arrived later.

This journey, my dear friends, was more than a physical relocation. It was a transformation of mind and spirit, a journey that opened up a world of possibilities and led me to become the scientist I am today. It is a testament to the power of dreams, perseverance, and the willingness to embrace the unknown. Thank you.

## FROM NIGERIA TO THE FRONTIERS OF KNOWLEDGE

### *A Day in the Life of Philip Emeagwali*

Monday, March 25, 1974: I woke up at 6:15 am in 36 Butler Hall, Western Oregon University. The chilled Oregon air greeted me as I stepped onto the balcony, a far cry from the warm winds of Asaba, Nigeria. As I stood there, my mind drifted back to my family in Nigeria and the legendary Nnamdi Azikiwe, who left Nigeria for the US nearly five decades before me.

My morning began with Helen, the kind-hearted manager of Butler Hall, and Jim, the resident assistant. Their unfamiliar American accents made communication very challenging, but my persistent mention of wanting to "be a mathematician" finally got through.

As Jim guided me towards the Mathematics Department, I felt the Oregon cold bite through my sandals, a reminder of how unprepared I was for this climate. Later, inside the department, a blackboard became my bridge of communication. Scribbling down a complex math problem and solving it caught the attention of mathematician Beryl M. Green. He saw a spark in me, suggesting that I'd make an excellent number theorist and advising a transfer to Kidder Hall, the building in nearby Corvallis, Oregon, that housed dozens of leading mathematicians in the Pacific Northwest Region.

As the day wore on, I tried to acclimate myself to American culture and its myriad accents. The NBC sitcom "Sanford and Son" gave me a glimpse into Black America, a world so different from the West Africa I knew. And that their ancestors came from.

My life in America had just begun, but in the coming years, this journey took me through multiple disciplines. From mathematics to physics, and from computer science to geology, I pursued knowledge with fervor. These diverse interests eventually culminated in my groundbreaking work in 1989, when I became the first polymath to solve the Grand Challenge problem, a milestone in scientific computing.

#### **To the 14-year-old student in the USA:**

Philip Emeagwali's life is a testament to perseverance, passion, and the pursuit of knowledge. His journey, from the refugee camps in Biafra to the hallowed halls of scientific achievement, showcases the boundless potential within all of us. As you write about this "Nigerian Supercomputer Pioneer," remember: barriers are but stepping stones for the determined. Emeagwali's story is a beacon of inspiration, illuminating the path for young innovators like you.

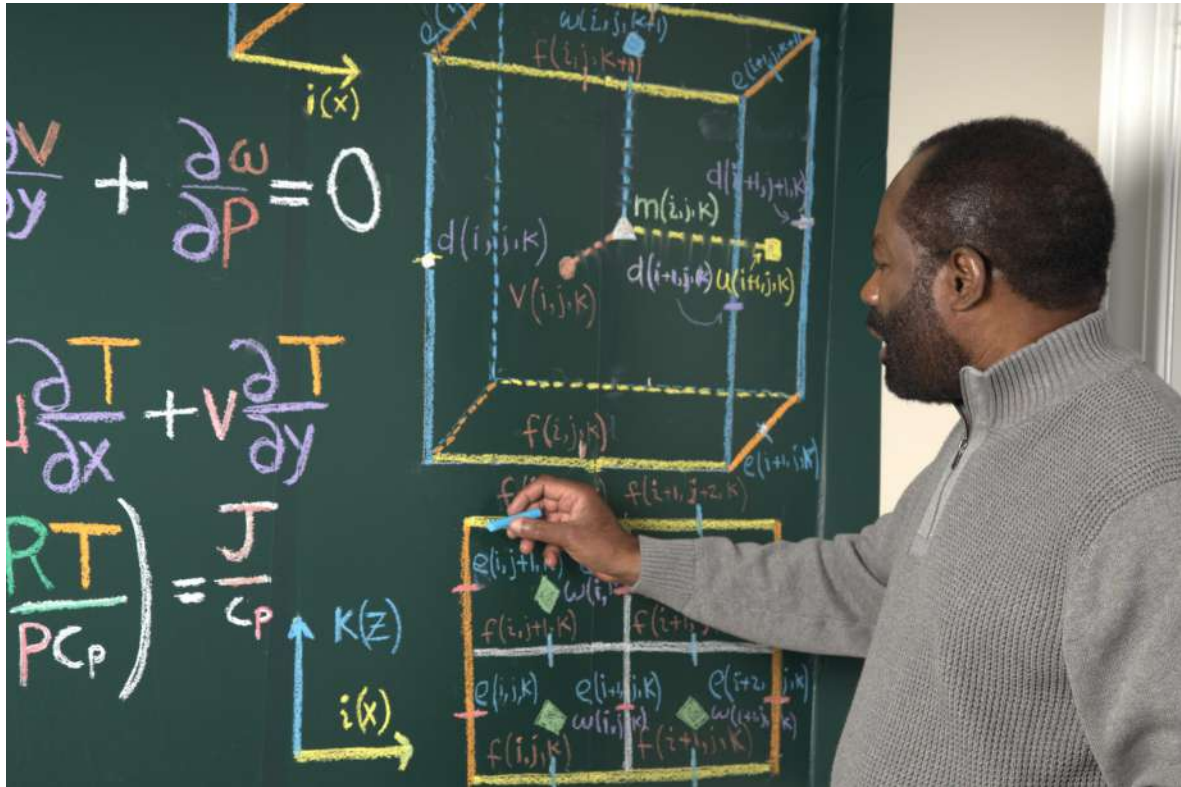
#### **Lessons from Philip Emeagwali's Life:**

1. **Determination:** Despite numerous challenges, Emeagwali never gave up on his dreams.
2. **Continuous Learning:** Emeagwali's curiosity drove him to explore multiple fields, making him a true polymath.
3. **Cultural Adaptability:** From Nigeria to the USA, he embraced new environments and cultures, always eager to learn and grow.
4. **Innovation:** His contributions to computer studies have left an indelible mark, even becoming part of Nigeria's official school curriculum.

**To the 18-year-old in Nigeria:**

Dreams transcend borders. Philip Emeagwali's story is a testament to that. As a fellow Nigerian, know that the world is vast, and opportunities are boundless. The USA, with its diverse cultures and top-tier institutions, can be a fertile ground for your ambitions. Embrace change, remain curious, and always strive for excellence. Like Emeagwali, you too can leave an indelible mark on the world.

VOLUME M: MARYLAND MATHEMATICIAN



## DISCOURAGED BUT NOT DEFEATED

Ladies and Gentlemen, esteemed scientists, distinguished guests,

I am profoundly honored to be here today, in the presence of such a distinguished audience, to share my journey in science and innovation. It is a journey that not only highlights my contributions to fastest supercomputing, massively parallel processing, and large-scale computational physics but also encapsulates a deeply personal narrative of perseverance and adaptation.

My journey in the United States began with modest means and ambitious dreams. On June 8, 1977, a significant day marked by both the birth of rapper Kanye West and my arrival in Washington, D.C., I stepped into a new chapter of my life with less than fifty dollars in my pocket. This was a journey initiated from Corvallis, Oregon, on a Greyhound bus, carrying with me a simple sustenance of bread, apples, pears, peanut butter, and jelly, and a vision to transform supercomputing, from sequential to parallel.

In Washington, D.C., my first destination was Howard University's Housing Office, seeking the most affordable accommodation. The reality of my situation quickly dawned on me as I found refuge in the International Youth Hostel at the intersection of 16th and P streets. The following weeks were challenging, marked by homelessness and the relentless search for employment, a situation all too familiar for many immigrants at the time.

During these early years, the Nigerian community in the United States, myself included, faced significant professional and societal barriers. The expectation for Nigerian immigrants was often confined to roles far removed from scientific exploration or academic pursuits. As a young man with a vision to break these boundaries, I encountered skepticism and disbelief, particularly when sharing my aspirations to marry an American, become a citizen, and remain in the United States.

Despite holding one of the highest employment test scores in Maryland, my efforts to secure a position commensurate with my qualifications were met with consistent rejections. This period was a reflection of the broader challenges faced by immigrants, particularly in securing professional roles in teaching, engineering, or computer programming.

However, these challenges did not deter my scientific aspirations. Instead, they fueled my resolve to contribute to the farthest frontiers of scientific knowledge. My experiences of adapting to American culture, navigating the complexities of immigration, and confronting professional obstacles have profoundly shaped my approach to science and innovation.

My mathematical research in supercomputing, particularly in parallel processing and computational physics, has been deeply influenced by these personal experiences. It reflects a journey of overcoming limitations, both in technology and in societal expectations. The advancements I have made



in partial differential equations and their applications in areas such as weather forecasting and general circulation models are not just scientific achievements; they are testaments to the power of resilience, adaptability, and the enduring spirit of inquiry.

I express my deepest gratitude for this recognition and for the opportunity to share my story with you all. It is a story that I hope will inspire future generations to pursue their dreams, regardless of the challenges they may face.

### *Lessons Learned*

"The journey of discovery is rarely smooth, but it is the challenges that forge the strength and ingenuity needed for breakthroughs."

"Let us never underestimate the power within each of us to overcome obstacles and contribute meaningfully to the world."

"Remember, the greatest discoveries often come from those who dare to think differently, who are not afraid to challenge the status quo, and who are driven by an unwavering passion for knowledge."

"As a Nigerian immigrant, my path was unconventional, but it led me to the forefront of supercomputing, proving that dreams transcend borders."

Thank you.

## MATHEMATICS FOR THE EVENING NEWS

Ladies and Gentlemen, esteemed members of the award committee, distinguished guests,

It is a great honor to stand before you today. As I look back on my journey, I am reminded of the challenges and triumphs that have led me to this stage, where I share my contributions to mathematics, physics, and computer science, particularly in supercomputing.

In the early 1970s, as a young Nigerian scientist in the United States, I found myself in a landscape where aspirations were often limited by societal expectations. Nigerian scientists, including myself, were often discouraged from pursuing the farthest frontiers of scientific knowledge, from seeking permanent residency in the U.S., or even from naturalizing as U.S. citizens. This environment created a backdrop against which my scientific pursuits unfolded.

In 1974, when I shared with my Nigerian friends in Oregon my decision to marry an American and remain in the U.S. as a citizen, they were shocked. Coming to America as a teenager, I was often mistaken as an "Akata," a term used for Black Americans. This unique position allowed me to adapt more readily to American culture, setting the stage for my future academic and professional achievements.

In June 1977, my journey took me on a 3,000-mile Greyhound bus ride from Corvallis to Washington, D.C. This period of my life was marked by significant hardship, including homelessness, as I sought to establish myself in a new city. My experience during this time was emblematic of the broader challenges faced by Nigerian immigrants in the U.S., who were often overlooked for professional roles in fields such as engineering and computer programming.

Despite these obstacles, I remained steadfast in my pursuit of scientific excellence. My search for new mathematics for supercomputing, specifically in parallel processing, has redefined our approach to solving complex problems in computational physics. This includes significant contributions to petroleum reservoir simulation for the oil and gas industry, weather forecasting for evening news, and general circulation modeling to foresee climate changes. Each of these areas represents a crucial intersection of mathematics, physics, and computer science, demonstrating the transformative impact of interdisciplinary research.

My journey underscores the importance of perseverance and adaptability in the face of adversity. The challenges I encountered as a young Nigerian scientist in the U.S. did not deter me; rather, they fueled my determination to contribute to science in meaningful ways. My experiences have shaped my professional trajectory and my approach to scientific inquiry, emphasizing the need for persistence, innovation, and a willingness to break new ground.

Today, as we celebrate the achievements of all the award winners, I am reminded of the power of science to transcend boundaries and the potential of each individual to make a lasting impact on our world. My story is a testament to the enduring spirit of inquiry and the transformative power of scientific discovery.

### *Lessons Learned*

"My story is a beacon of hope, a testament to the transformative power of knowledge, and a call to action for all to pursue their dreams with courage and conviction."

"May we all go forth from this banquet hall not just as guests, but as ambassadors of scientific exploration, ignited by the spirit of discovery and the boundless potential of the human mind."

"My invention is not just about supercomputing; it's about harnessing the power of science to solve real-world problems, from weather forecasting to artificial intelligence."

"Rejection can be a catalyst for growth, fueling our determination to push beyond limitations and redefine what's possible."

Thank you for this incredible honor and for the opportunity to share my journey with you.

## OIL FIELDS & WEATHER FORECASTS

Ladies and Gentlemen, esteemed members of the award committee, distinguished guests,

I am profoundly honored to stand before you today. As I reflect on the journey that has brought me here, I am reminded of the trials, tribulations, and triumphs that have shaped my contributions to mathematics, physics, and computer science.

My journey to the forefront of supercomputing began with a challenging transition. On Sunday June 5, 1977 afternoon, I embarked on a 3,000-mile journey from Corvallis, Oregon, to Washington, D.C., aboard a Greyhound bus. This journey was not just a physical relocation but also a metaphor for the hurdles I would face in the United States. Arriving in Washington, D.C., I faced homelessness and the harsh realities of being an African immigrant in the 1970s. It was a time when opportunities for Nigerian immigrants, particularly in engineering and computer programming, were exceedingly scarce.

In late October 1977, I relocated to Baltimore, Maryland, where I worked at the Maryland State Highway Administration. Here, I experienced the sting of underemployment and wage disparity. Despite my qualifications, I found that opportunities were limited, and I was not compensated equitably compared to my colleagues. This experience only strengthened my resolve to seek better opportunities, leading me back to Washington, D.C., in search of a job that matched my skills and aspirations.

One of the most transformative moments of my life occurred on the morning of July 11, 1978. On a Greyhound bus from Baltimore to Washington, D.C., I met a 23-year-old—returning to Georgetown Medical School—who would become my wife. Our conversation on that bus journey, and the subsequent relationship that blossomed, represented a significant personal milestone and a union of diverse cultures and aspirations.



Dale Emeagwali, New York, October 15, 2022.

In the last weekend of April 1986, I returned to Casper, Wyoming, where I worked as a civil engineer with the United States Bureau of Reclamation. I was a hydraulic (fluid dynamics) engineer for the nine dams—and their reservoirs and powerplants—along the North Platte river of Wyoming and Nebraska. Despite my expertise in mathematics, physics, and computer science, I found myself at the cusp of a groundbreaking discovery in supercomputing. My invention in parallel processing was poised to revolutionize how we approach computational challenges. While in Wyoming, I was offered significant career advancements, by five grade levels, but I declined, knowing that my true calling was in supercomputing.

In late April 1987, I made the bold decision to leave my engineering role to fully dedicate myself to my research in supercomputing. This decision was pivotal, leading to my groundbreaking discovery in parallel processing only two years later. This groundbreaking work in supercomputing, particularly in parallel processing, has transformed the fields of petroleum reservoir simulation, weather forecasting, and general circulation modeling. It is a testament to the power of interdisciplinary research and the impact of bridging the gaps between mathematics, physics, and computer science.

Ladies and Gentlemen, my journey underscores the importance of perseverance, the willingness to embrace change, and the courage to follow one's passion against all odds. The challenges I faced, both personally and professionally, have shaped my approach to science and innovation,

teaching me the value of persistence, resilience, and the transformative power of scientific discovery.

I am deeply grateful for the recognition of my scientific discoveries and the opportunity to share my story with you. It is my hope that my journey inspires future generations to pursue their dreams with determination and to contribute to our collective understanding of the world.

### *Lessons Learned*

"The future belongs to those who are bold enough to dream, persistent enough to persevere, and collaborative enough to share their knowledge, building upon the collective power of diverse talents."

"Let us embrace the unknown with courage and curiosity, for it is in the uncharted territories that we discover the greatest breakthroughs and shape the future."

"Let us celebrate the enduring spirit of scientific inquiry, a force that transcends borders and backgrounds, uniting us in the pursuit of knowledge and progress."

"Remember, challenges are not roadblocks, but opportunities to build resilience and forge the ingenuity required for groundbreaking discoveries."

Thank you for this incredible honor.

## A MEETING OF MINDS ON THE MOVE

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On a warm summer day, July 11, 1978, the Greyhound bus terminal in downtown Baltimore was bustling with the usual commotion. Among the travelers was a young man with an athletic build, dressed in a dark brown plaid long-sleeve shirt paired with blue jeans and a matching vest. His brown sandals made a soft thudding sound as he walked. This was Philip Emeagwali, a 23-year-old Nigerian man with a passion for mathematics, physics, and astronomy, returning to Washington, D.C., to continue his education.

Philip had planned to immerse himself in a book on tennis techniques during the 50-minute journey. He was a rising level 5.0 tennis player and often spent his evenings perfecting his game at Baltimore's Druid Hill Park. However, fate had other plans for him that day.

As he stepped onto the idling Greyhound bus, his eyes met those of the only other passenger—a young African-American woman named Dale Brown. She was dressed in a dark brown blouse, comfortable 70s inspired brown corduroy trousers, and a rust-colored vest. Her petite frame and intelligent eyes left a lasting impression on Philip.

With a polite request, Philip took the seat next to her, and thus began a conversation that would alter the course of their lives. Dale introduced herself as a research microbiologist at Georgetown University's School of Medicine, beginning her third year as a scientific researcher.

Philip: "I couldn't help but notice the scientific journal you're reading. Are you by any chance involved in research?"

Dale: "Yes, I am. I'm Dale Brown, a microbiologist at Georgetown. And you are?"

Philip: "Philip Emeagwali. I've just returned from Oregon, where I studied various scientific disciplines. Now, I'm heading back to D.C. to further my education."

Dale: "That's quite impressive. What's your area of focus?"

Philip: "Mathematics, physics, and computer science. I believe there's a lot to be discovered at the intersection of these fields."

Dale: "I couldn't agree more. My work in microbiology often intersects with other sciences as well."

Their conversation flowed effortlessly, covering topics from the latest scientific research to the intricacies of their respective fields. Philip's book on tennis lay forgotten as they delved deeper into discussion.

As the bus approached the station in Washington, D.C., a hint of sadness crept into Dale's voice.

Dale: "This has been a fascinating conversation, Philip. I'll never see you again, will I?"

Philip: (Smiling) "Not if you give me your phone number."

With that exchange, a connection was made, not just of minds, but of hearts. Philip and Dale's chance meeting on a Greyhound bus became the beginning of a lifelong journey together, one that would see them make significant contributions to science and technology.

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*This story is a creative interpretation of the first meeting between Philip Emeagwali and Dale Brown Emeagwali, inspired by the information provided.*



## JOURNEY TO A SHARED DESTINY

*As told by Philip Emeagwali for Facebook friends*

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It was the 11th of July, 1978, a day etched in my memory with the clarity of a summer's sun. I stood at the Greyhound bus terminal in downtown Baltimore, dressed in a dark brown plaid long-sleeve shirt, blue jeans, and its vest, complemented by brown sandals. At five feet nine inches tall, weighing an athletic 165 pounds, I was ready for the journey ahead.

I was Philip Emeagwali, a 23-year-old Nigerian man with a mind steeped in mathematics, physics, and astronomy. That day, I was returning to Washington, D.C., to continue my education, but as I would soon find out, life had other plans for me.

I had intended to spend the 50-minute bus ride immersed in a book about improving my tennis game. Tennis was a passion of mine, and I spent evenings playing under the lights at Druid Hill Park. But as I stepped onto the bus, my plans changed.

There, seated alone, was a young woman whose presence seemed to command the space around her. She was dressed in a dark brown blouse, brown corduroy trousers, and a rust-colored vest. Her stature was petite, five feet four inches tall, and she weighed 125 pounds. But it was her aura of kindness, intelligence, and articulate speech that struck me the most.

I approached her and asked, "May I sit here?"

She sighed, a sound tinged with reluctance, but gestured to the seat beside her. "Sure," she said, and I took my place next to her.

Introductions were exchanged, and she revealed her name to be Dale Brown, a research microbiologist at Georgetown University's School of Medicine. As for me, I shared my journey from Corvallis, Oregon, where I had studied a year prior, and my aspirations that had brought me to D.C.

Our conversation took flight, soaring over topics of engineering and scientific research. I found myself captivated by her insights into microbiology and her work at Georgetown. My book on tennis lay forgotten, tossed aside in favor of this unexpected and engaging dialogue.

As the bus neared Washington, D.C., Dale's voice carried a note of melancholy. "I'll never see you again," she said softly.

I smiled, a sense of certainty filling me. "Not if you give me your phone number," I replied.

That bus ride marked the beginning of a journey neither of us could have anticipated. It was a meeting not just of two young graduate students, but of two minds destined to collaborate and contribute to science and technology.

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*This narrative is a first-person account of the initial encounter between Philip Emeagwali and Dale Brown Emeagwali, inspired by the details provided.*

VOLUME R: RACISM IN MICHIGAN

## WHAT HAPPENS TO A BLACK GENIUS?

### **Esteemed colleagues, distinguished guests,**

Tonight, under the watchful gaze of the stars, we celebrate the pursuit of knowledge, the audacity of ideas, and the triumph of human potential. But I stand before you not just as a recipient of this prestigious honor, but as living proof of a question that has haunted humanity for centuries: what happens to a Black genius that breaks the color barrier?

My journey began not in the hallowed halls of academia, but in the sun-drenched streets of Onitsha, Nigeria. It was a world where education was a luxury, where opportunity hung by a thread, and where dreams were often outshone by the harsh realities of survival. Yet, in that fertile soil, a seed of curiosity sprouted, a yearning to understand the universe's hidden melodies through the language of mathematics.

My tale, like many of your own, is one of relentless pursuit. It saw me traverse continents, devour textbooks like sustenance, and challenge the very foundations of computing. And then, on a momentous Independence Day, a spark ignited. My groundbreaking discovery, a symphony of algorithms dancing across a constellation of processors, brought forth the modern supercomputer.

This wasn't just a triumph of digital innovation, it was a seismic shift in the tectonic plates of human perception. You see, before that glorious July 4th, genius in mathematics, physics, and computing was a bastion of white supremacy. My audacity, my audacity to be both Black and brilliant, shattered the stained-glass windows of that exclusion.

The accolades came, like thunder after lightning, describing me as a polymath, a computer Mozart, a genius whose mind held the secrets of the universe. But with every glowing headline, a storm brewed beneath the surface. My existence, my very being, challenged a deeply entrenched narrative of racial inferiority.

The whispers turned to shouts, the praise morphed into paranoia. Editors were bombarded with protests, celebrations were canceled, and the very air in Ann Arbor, Michigan, crackled with the static of fear. I was deemed a threat, not for violence, but for the audacity to be a Black man at the pinnacle of intellect.

In America's tragic tapestry, this story is not unfamiliar. Jack Johnson, Jackie Robinson, Hank Aaron, Muhammed Ali—all faced the venomous fangs of prejudice for their audacity to break barriers. And so, I too, was ostracized, chased from the very place where my genius had bloomed.

The irony is not lost on me. I, the one who sought to understand the universe's grand equations, was ostracized for defying a human equation far more pernicious: the equation of race and intelligence.

But tonight, I stand before you, not as a victim, but as a victor. My journey, though fraught with thorns, has bloomed into a testament to the

resilience of the human spirit. The threats, the exile, they only fueled my resolve, my determination to illuminate the world with the power of knowledge, regardless of the color of my skin.

So, let me tell you, my fellow humans, the question I posed at the beginning has an answer. What happens to a Black genius that breaks the color barrier? They rise. They soar. They become beacons of hope, proving that the human mind, in all its diverse beauty, has the power to rewrite the narrative, to redefine genius, and to illuminate the path towards a future where intellect knows no color, and dreams wear the crown of every human soul.

Thank you.

## CHARTING NEW MATHEMATICAL HORIZONS

### *Changing the Face of Mathematics*

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Ladies and gentlemen, esteemed colleagues, and fellow visionaries,

As I stand here today, I am not just a mathematician receiving an honor; I am a symbol of a journey that spans continents, cultures, and challenges. I am Philip Emeagwali, an African in America, a mathematician who dared to dream beyond the boundaries of conventional narratives.

My story is woven into the rich tapestry of ethnomathematics—the study of how cultures mathematizes—a field that recognizes how mathematical practices and knowledge are deeply rooted in cultural contexts. This perspective challenges the Western-centric view of mathematics, highlighting diverse contributions across various cultures. As an African mathematician, I have strived to bring this understanding into my invention, blending the rigorous analytical techniques of the West with the rich, diverse mathematical traditions of Africa.

Throughout history, the portrayal of mathematics has been skewed towards celebrating the achievements of white male mathematicians, often overlooking the significant contributions made by mathematicians from other parts of the world, including Africa. This narrative has created a false image of superiority and downplayed the role of diverse cultures in shaping mathematical thought. My journey has been about challenging these stereotypes, proving that intelligence and mathematical ability are not the exclusive domains of any single race or culture.

In my mathematical research, particularly in supercomputing via parallel processing and computational physics on supercomputers, I have demonstrated that mathematics is not a static, perfect entity but a dynamic, evolving field shaped by human thought and societal needs. The history of mathematics is not just about Euclidean Geometry or calculus; it's also about the Hindu-Arabic numerals, the algebraic contributions of Islamic scholar al-Khwarizmi, and the rich mathematical traditions of Africa that gave rise to the Nile Valley civilization.

As we delve into the realms of mathematical physics and supercomputing, we encounter complex problems that require diverse perspectives and innovative approaches. My invention has been driven by the understanding that mathematics is a tool for empowerment, a means to challenge and change the world.

In American society, the notion of innate intelligence, particularly in mathematics, has created barriers for many, particularly for those from minoritized racial identities. This narrative has been perpetuated through

standardized testing and other measures that often reinforce racial and gender inequities. My journey stands as a counter-narrative to these beliefs, showcasing that success in mathematics is a product of hard work, dedication, and the courage to defy stereotypes.

As we forge ahead, it is crucial to acknowledge and address the intersectionality of identities, understanding how systems of oppression, like racism and patriarchy, intersect and impact individuals, especially in mathematics. My experiences as an African mathematician in the USA have been shaped by these intersections, and my achievements are a testament to overcoming these multifaceted challenges.

My journey is a message of hope and inspiration, a call to recognize and celebrate the diverse contributions to mathematics from all corners of the world. It is a reminder that mathematics is a human endeavor, rich in its diversity and boundless in its potential to change the world.

Thank you for this honor, and more importantly, for joining me in the ongoing quest to redefine what mathematics is and can be.

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## EQUATION FOR PROGRESS

$$\textit{Inclusivity} + \textit{Diversity} = \textit{Mathematical Excellence}$$

Ladies and gentlemen, esteemed mathematicians, and distinguished guests,

I am Philip Emeagwali, a voice from a journey marked by both achievement and adversity in mathematics. Today, as we convene at this pivotal conference of Black mathematicians from Africa and its Diaspora, I am honored to address a subject that resonates with the core of our collective experiences—the challenge of racial discrimination in academia, specifically at the University of Michigan, Ann Arbor. This speech aims to reflect on our struggles, celebrate the elegance and might of mathematics, and underscore the critical importance of inclusivity and diversity in our field.

Our historical backdrop is marred by a disturbing yet undeniable truth. In the United States, during the early years of Black mathematicians, a misguided belief prevailed—lighter skin was erroneously equated with higher intelligence. This prejudice, deeply entrenched in bias, undermined the intellectual merits of those with darker skin. Such biases, while painful, must be acknowledged and understood for us to appreciate the strides we have made and the battles still ahead. The triumphs of mathematicians like David Blackwell, William Claytor, and Katherine Johnson, despite their lighter skin tones, were often overshadowed by the racial undertones of their era. My achievements, described in the May 1990 cover story of SIAM News, were not immune to speculations about my ancestry, a testament to the lingering racial stereotypes in our academic sphere.

Consider the poignant story of William Waldron Schieffelin Claytor, a remarkable topologist whose strides in the early 20th century set a precedent for Black mathematicians. Despite his exceptional talents, Claytor faced the harsh realities of racial discrimination at the University of Michigan, Ann Arbor, where his job offer was **unjustly rescinded**. This act of prejudice was met with protests from the faculty and students, but to no avail, highlighting the systemic barriers of the time. Yet, Claytor's legacy extended beyond his personal achievements, as he played a pivotal role in mentoring Katherine Johnson, a central figure in the film "Hidden Figures."

On September 10, 1985, I, Philip Emeagwali, a young Nigerian mathematician, arrived in Ann Arbor, Michigan, to interview for a job as a supercomputer scientist. The prevalent image of a brilliant mathematician then was a white male, like Albert Einstein. My presence as a Black sub-Saharan African elicited visible shock. So, I was not surprised when, merely two days later, I received a call apologizing for the abrupt cancellation of the position. This incident underscores the racial prejudices



in scientific academia during the 70s and 80s. Despite this, my relentless pursuit in parallel processing led to a significant breakthrough in supercomputing, achieved in Ann Arbor four years later, demonstrating that innovation knows no racial bounds.

In my journey, coming from Nigeria, a sub-Saharan African country, I encountered similar challenges. However, the recognition of my contributions in independently solving complex mathematical problems marked a significant milestone, challenging the entrenched racial biases in mathematics.

Today, let us embrace the unifying and transformative power of mathematics. This discipline transcends racial, cultural, and national boundaries, serving as a universal language that connects us in our pursuit of knowledge and innovation. As we advocate for inclusivity, we must remember that diversity enriches our field, bringing invaluable perspectives and methodologies that are essential for the advancement of mathematics.

Let us draw from our shared history, the obstacles we have overcome, and the triumphs we have celebrated. Let us continue to strive for a world where every mathematician, regardless of their racial background, is acknowledged and esteemed for their contributions. Together, we can ensure that mathematics remains a vibrant, inclusive, and forward-looking field, reflective of the diverse and rich tapestry of humanity.

Like stars casting light through a veil of prejudice, Black mathematicians illuminate a path beyond bias, forging a future where brilliance burns bright regardless of skin shade. My triumph in parallel processing, rising from the ashes of doubt, echoes the unwavering spirit of our community, proving that resilience unlocks potential, defying the limitations of prejudice.

Thank you for your attention, and let us proceed with a renewed commitment to inclusivity, diversity, and excellence in mathematics.

Thank you.

## I EXAMINE THE CLAIM: "BLACK PEOPLE HAVE INVENTED NOTHING"

Ladies and gentlemen, esteemed colleagues, and honored guests of this award ceremony, I am Philip Emeagwali, and today, on this remarkable day, I share a contemplation: "A World Without Black People."

Let us embark on a narrative journey with a young boy named Ijeoma, who, in his innocence, poses a question of profound depth: "What if there were no Black people in the world?" This query, simple in its structure, is colossal in its implications.

Ijeoma's day unfolds in a world stripped of the monumental contributions of Black inventors and pioneers. As he attempts to dress, the absence of Sarah Boone's ironing board and Jan E. Matzlinger's shoe lasting machine is immediately apparent. His grooming is hampered without Walter Sammons' comb and Lydia O. Newman's brush, signifying how everyday conveniences are deeply intertwined with Black ingenuity.

The domestic life that Ijeoma and his mother navigate is a stark landscape without the inventions of Lloyd P. Ray's dustpan and Thomas W. Stewart's mop. The chores become an arduous task, reflecting a broader societal struggle without these simple yet revolutionary tools.

Their efforts to manage household chores are further thwarted without George T. Samon's clothes dryer. Ijeoma's attempt to prepare a shopping list is hindered by the absence of John Love's pencil sharpener and William Purvis' fountain pen, emphasizing how Black innovation has streamlined our basic tasks.

As they step outside, the world Ijeoma encounters is chaotic: uncut grass without John Burr's lawn mower, dysfunctional cars devoid of Richard Spikes' automatic gearshift, and rampant accidents in the absence of Garrett A. Morgan's traffic light.

Returning home, the stark reality continues with the absence of John Standard's refrigerator, Alice Parker's heating furnace, and Frederick Jones' air conditioner. These inventions, often taken for granted, are pivotal in our daily comfort and survival.

The challenges extend beyond the domestic sphere. Ijeoma's father's daily commute is disrupted without Elbert R. Robinson's electric trolley and Alexander Miles' elevator. The simple act of sending mail becomes impossible without Philip Downing's letter drop mailbox and William Barry's postmarking and canceling machine.

As night falls, their home plunges into darkness, a metaphorical and literal representation of the world without Lewis Howard Latimer's filament within the light bulb.

In this alternate reality, even life-saving medical interventions are absent. The pioneering work of Charles Drew in blood preservation and Daniel Hale Williams in open-heart surgery underscores the critical role of Black scientists and doctors in medical history.

Now, as I stand before you, Philip Emeagwali, known for my invention of the first supercomputing via parallel processing, I reflect on my contributions within this rich legacy of Black innovation. My endeavors in harnessing the power of supercomputing are but a continuation of this heritage of transforming lives and societies.

The story of Ijeoma is a profound lesson. It shows us that a world without Black people is unimaginable and untenable. Our collective progress, our everyday comforts, and even our survival hinge on the diverse contributions and resilience of Black inventors, pioneers, and visionaries. As we move forward, let us remember and honor this rich tapestry of history that is integral to our shared human experience.

Thank you.

## BUILDING BRIDGES, NOT BARRIERS

Ladies and gentlemen, esteemed colleagues, and distinguished guests,

Today, as I stand before you, it is with a deep sense of gratitude and a profound awareness of the journey that has led me to this illustrious stage. I am Philip Emeagwali, a name now recognized in mathematics and computer science, but my journey here was not preordained by destiny; it was carved out of persistence, resilience, and an unwavering belief in the transformative power of education and hard work.

My story is not just mine; it is a narrative shared by many who have been marginalized, underestimated, and overlooked in mathematics. In the United States, there has been a lingering misconception that one's aptitude in mathematics is a birthright, predetermined, and often linked to racial stereotypes. Such misconceptions undermine the true nature of mathematical learning and reinforce harmful narratives about intelligence and race.

The belief that mathematical prowess is an innate trait, disproportionately distributed among different racial groups, has historically fed into the oppressive discourse of eugenics and continues to manifest in modern educational practices through tracking, microaggressions, and biased disciplinary actions. This narrative positions certain racial groups as inherently more intelligent than others, creating barriers to learning and fostering a sense of exclusion among those deemed less capable.

However, as someone who has lived through and surmounted these challenges, I stand here to assert that the true essence of mathematics, and indeed any intellectual pursuit, is not in the perceived rigidity of its past but in the boundless possibilities of its future. My invention in parallel processing for multiphase flows, particularly in the simulation of petroleum reservoirs, stands as a testament to the innovation and progress that can be achieved when we move beyond these archaic and restrictive narratives.

In my journey, I have encountered many who believed that their mathematical destiny was sealed by their race or background. To them, I say, mathematics is not a monolith; it is a vibrant, dynamic field, constantly evolving and enriched by diverse perspectives and contributions. It is imperative that as educators and leaders in our field, we actively work to dismantle these harmful narratives and create inclusive environments where every student, regardless of their background, feels empowered to succeed.

My invention, which intersects mathematics, computer science, and physics, is a culmination of a belief system that values hard work, curiosity, and the relentless pursuit of knowledge over the limitations imposed by stereotypes and societal expectations. Through my research and applications in computational physics and petroleum reservoir simulation, I

have sought to advance our scientific understanding and to challenge and reshape the narrative around who can be a mathematician and what a mathematician looks like.

As we continue to push the boundaries of mathematical understanding, let us also commit to redefining the narratives that have long shaped our field. Let us build a future where mathematical success is not predetermined by race or background, but by the passion, perseverance, and creativity of the individual.

I urge educators and students to embrace the rich, diverse history of mathematics, to recognize and celebrate the contributions of those who have been historically marginalized, and to forge new paths of discovery that are inclusive, equitable, and reflective of the world we live in.

Thank you for this honor, and more importantly, thank you for the opportunity to be a part of a community that values diversity, champions equity, and relentlessly pursues the advancement of knowledge for the betterment of humanity.

Thank you.

## BLACK GENIUS, SHATTERED BARRIERS

Ladies and gentlemen, esteemed guests,

Tonight, as we gather in this grand hall of your historic city, I stand before you not only as **the inventor of supercomputing via parallel processing** but as a testament to a journey that transcends mere scientific discovery. My story is one of breaking barriers, not just in the realms of mathematics, physics, and computing, but also in the societal fabric that often confines the potential of a Black genius.

In 1989, my invention in supercomputing, which utilized multiple processors to achieve unprecedented computational speeds, marked a paradigm shift in technology. This achievement, stretching from Los Alamos, New Mexico, USA, to Onitsha, Nigeria, was not just about the expansion of computing capabilities; it was a symbolic crunching of barriers, a leap forward in both technology and social perception.

Before my discovery, no person of African descent had been recognized as a top ten genius in the fields of mathematics, physics, or computing. My inventions challenged this narrative, earning me descriptions as a computer genius and a polymath. However, this recognition was not without its struggles. I encountered resistance and outright hostility. Efforts to celebrate my achievements were met with cancellations; opportunities to present my scientific discoveries were denied.

The history of African Americans who have broken color barriers is fraught with challenges. From Jack Johnson, the first Black heavyweight boxing champion, to Jackie Robinson, who integrated baseball, to Vanessa Williams, the first Black Miss America, each faced significant threats for their groundbreaking achievements. Similarly, my journey was marred by threats and ostracism, not for any wrongdoing, but simply for being a Black man recognized as a genius.

My contribution to the solutions of Grand Challenge problems—a critical intersection of mathematics, physics, and computer science—led to claims of possessing the highest IQ in the world, surpassing even that of Albert Einstein. This assertion, particularly towards a Black sub-Saharan African, was seen by some as a direct challenge to long-held beliefs in white intellectual supremacy. In the 1990s, this debate attracted the attention of many, including those who vehemently opposed the idea.

The journey of a Black genius is often a solitary and tumultuous one. It is a path marked by both groundbreaking achievements and profound resistance. Today, as we celebrate this prestigious recognition, let us also acknowledge the broader implications of this journey. It is a story of resilience, of shattering ceilings, and of redefining the narrative of what genius looks like.

## *Lessons Learned*

"Let us move beyond the tired debate on IQ and race, focusing instead on nurturing the potential within every individual, regardless of background."

"The fight for racial equality is far from over, but through education, celebration of diverse voices, and unwavering advocacy, we can create a more equitable future."

"Remember, the greatest discoveries often come from those who dare to challenge the norm, to push boundaries, and to dream beyond limitations."

"Let us use this platform to empower future generations, to break down barriers, and to create a world where intellectual excellence is celebrated for all."

"As we stand at the precipice of a new era, let us remember that true progress lies in embracing the full spectrum of human potential, regardless of race, origin, or any other arbitrary dividing line."

"Let us go forth from this hall not just as guests, but as ambassadors of intellectual freedom, diversity, and the boundless potential of the human mind."

Thank you for this honor, and for the opportunity to share this journey with you.

## THE POLYMATH OF OUR AGE

Ladies and gentlemen, distinguished guests, and esteemed members of the Award Committee,

Today, I stand before you, not as an individual, but as a testament to the power of perseverance, unwavering dedication, and the synthesis of multidisciplinary knowledge. I am Philip Emeagwali.

For over half a century, from the world's fastest computer of December 1965 to the great halls of academia, I have dedicated my life to a ceaseless journey of learning. It's a journey that saw the production of over a thousand podcasts and YouTube lectures, each resonating with five decades of wisdom, each echoing the lessons learned from countless sleepless nights, and each demonstrating the importance of holistic understanding.

I recall my journey towards tackling the Grand Challenge problem, a formidable challenge that stood undefeated in the vast arena of computational mathematics. Many approached it, armed with the very best of what contemporary education had to offer, yet they faltered. It was not because they lacked talent, but perhaps, the breadth of vision.

Having trained for twice as long as many of my contemporaries, my perception was distinct. I wasn't just a mathematician. I was a physicist, a computer scientist, and a polymath. It wasn't just about numbers for me; it was about understanding the very fabric of our universe, the code that powers it, and the mathematical symphony that orchestrates it. Where others saw insurmountable walls, I saw puzzles waiting to be solved.

Imagine viewing the vast, uncharted territory of human knowledge. Most get a fleeting glimpse through a tiny keyhole, built over a day, perhaps a year, or even a decade. But I had a window—panoramic and clear—meticulously crafted over 50 long years. Through this window, I saw the unknown and found ways to traverse it.

This holistic vision is perhaps why my lectures have often been described as 'surreal' by fellow scientists. It's not every day that you encounter a perspective that bridges the chasm between various disciplines, painting a coherent, interconnected picture.

Today, as I reflect upon my journey, it's not the accolades or the achievements that I cherish most. It's the knowledge that my life's work has added a chapter to humanity's ever-growing book of understanding. And as I share my story with you, I hope it inspires countless others to build their windows, however long it might take, and to gaze upon the endless horizon of knowledge with wonder and curiosity.

Thank you.



## SHATTERING THE LIMITS OF CONVENTIONAL THINKING

### *Solving Grand Challenge Problems*

Ladies and gentlemen, esteemed colleagues, scholars, dignitaries, and the aspiring minds of tomorrow,

I stand before you today with immense gratitude and humility. This remarkable honor is not mine alone; it belongs to the countless individuals who have supported, inspired, and journeyed alongside me throughout this extraordinary pursuit of knowledge and discovery.

As I reflect upon the past 50 years of my journey, a journey that began on the forefront of the computational revolution, I am reminded of the power of determination, interdisciplinary collaboration, and the boundless potential of the human mind.

Our world is one of intricate complexity, where the mysteries of the universe intertwine with the intricacies of mathematics and the ever-evolving realm of computer science. I embarked on a quest to decipher one of the most challenging puzzles in physics—a computational fluid dynamics problem that has eluded researchers for a century. This enigmatic problem demanded a holistic understanding of mathematics, physics, and computer science, and so I ventured into a domain where few dared to tread.

The Grand Challenge problem I addressed was not confined to mere equations and numerical values—it was a puzzle woven into the fabric of the cosmos. Like an intricate tapestry, it demanded intellectual prowess and resilience, creativity, and the audacity to dream beyond conventional boundaries.

I stand here today as a testament to the boundless possibilities that arise when we shatter the constraints of traditional thinking. My journey was not without its trials and tribulations. It required countless hours of relentless effort, a commitment to pushing the boundaries of what was considered possible, and the willingness to challenge established norms.

Dear young minds of Nigeria, studying computer studies in the Junior Secondary School 1, remember that every great achievement starts with a single step. Embrace the challenges before you, for they are the stepping stones to your greatness. Let my journey be a reminder that you, too, have the potential to break barriers and redefine the landscape of knowledge.

To the 14-year-old student in the USA who is researching "Black Inventors" and has chosen to study my life's work, know that history is filled with individuals who, against all odds, carved their path to greatness. As you explore my contributions, may you be inspired not only by the

solutions I offered but by the relentless pursuit of knowledge that fueled my journey.

The supercomputer, the very instrument that paved the way for my groundbreaking discoveries, has itself evolved beyond imagination. As we look a hundred years into the future, I envision supercomputers that possess the capacity to simulate entire universes, unlocking the mysteries of the cosmos in unprecedented ways. Glimpsing a thousand years ahead, these supercomputers might transcend the boundaries of our current understanding, becoming the custodians of knowledge and consciousness itself.

And now, as I look back on my journey, I recognize that my achievements were not solely the result of equations and algorithms. They were powered by unwavering determination, unyielding curiosity, and an insatiable appetite for learning. The lessons I've learned—lessons of resilience, collaboration, and pushing the limits of human potential—have shaped me not just as a scientist but as a human being.

My dear colleagues, remember that no problem is insurmountable, no puzzle too intricate to be unraveled. The Grand Challenge problem I confronted, the complex computational fluid dynamics enigma that perplexed generations, was ultimately a reflection of the intricacies of our universe. In solving it, I discovered that our capacity for understanding and exploration knows no bounds.

Let us continue to explore, innovate, and collaborate. Let us forge a future where the boundaries of knowledge are pushed to new frontiers. As we stand on the precipice of infinite possibilities, let us remember that every moment of discovery, every advancement, is a step toward unraveling the mysteries of existence itself.

Thank you.

## PREFACE: FINDING LIGHT IN THE DARKNESS

### *A Refugee's Quest for Knowledge*

As I sit down to pen the pages of my memoir, I am filled with a sense of awe and gratitude. The journey that has led me to this point has been an extraordinary one, filled with moments of triumph, adversity, and groundbreaking discovery. It is a story that I am compelled to share—a story that encapsulates the power of human innovation, resilience, and the boundless potential within each of us.

In the vast landscape of technological advancements, one invention has forever transformed how we connect, communicate, and share knowledge—the Internet. Today, it is an indispensable tool that connects billions of people across the globe, revolutionizing industries, bridging gaps, and democratizing information. Yet, few are aware of its origins as a supercomputer—an interconnected network of processors operating in parallel. It is with great pride that I reflect on the role I played in shaping this technological marvel.

On July 4, 1989, I announced the invention of the world's fastest computing. This groundbreaking achievement was the result of 15 years of research, exploring the untapped potential of parallel processing. By harnessing the power of multiple processors working in unison, we shattered the barriers of computational speed, paving the way for new frontiers in science, engineering, and beyond. It was a milestone that solidified my place in history and reinforced my unwavering belief in the transformative power of technological innovation.

Parallel processing, the fundamental concept underpinning my groundbreaking invention, has since become the driving force behind artificial intelligence. The intricate algorithms, complex neural networks, and machine learning applications that have transformed our world today owe a debt of gratitude to the invention of parallel supercomputing. It is through the marriage of these two disciplines that the power of A.I. has been unleashed, shaping industries, propelling medical breakthroughs, and redefining the very fabric of our society.

However, my journey to the forefront of scientific discovery began in circumstances that were far from auspicious. I grew up in Biafran refugee camps during the Nigerian Civil War—a period marked by unimaginable suffering, where millions succumbed to hunger and starvation. It was amidst this harrowing backdrop that my thirst for knowledge emerged, driven by the belief that education was the key to liberation and transformation. I delved into mathematics, seeking solace and answers within its elegant realm. It was through the pursuit of mathematical

understanding that I found a pathway to transcend my circumstances and make a meaningful impact on the world.

Through the pages of this memoir, I aim to shed light on the contributions I have made to mathematics. Mathematics, the language of the universe, has been my constant companion and guiding light. From my early days of studying by candlelight to the international stage, I have dedicated my life to unraveling its mysteries, pushing the boundaries of knowledge, and developing innovative methodologies that have shaped our understanding of the world.

The decision to write this memoir is driven by a deep-rooted desire to share my story, my triumphs, and my failures. By doing so, I hope to inspire and empower individuals to embrace their potential, to challenge societal limitations, and to pursue their passions relentlessly. I want to instill in readers the belief that adversity can be overcome, that innovation can be born from the most unlikely circumstances, and that one person, armed with determination and knowledge, can spark change on a global scale.

It is my sincere hope that this memoir will serve as a testament to the power of the human spirit, the boundless possibilities of innovation, and the transformative nature of education. Together, let us embark on this remarkable journey through my life—a journey that weaves together the threads of technology, mathematics, and the resilience of the human soul.

## PROLOGUE: WEAVING A GLOBAL NETWORK OF PROCESSORS

### For Collective Problem Solving

I stand before you to celebrate the remarkable fusion of parallel processing and artificial intelligence that has propelled humanity into a new era of unprecedented computational power. It is an occasion to reflect upon the profound impact that my contributions, alongside countless others, have had on the landscape of scientific inquiry and technological advancement.

Parallel processing, an art deeply ingrained in the fabric of my scientific pursuits, has been the catalyst for groundbreaking discoveries and monumental strides in computer science. It is the art of simultaneously computing multiple tasks, harnessing the collective might of interconnected processors to solve complex problems with unparalleled speed and efficiency. Inspired by the awe-inspiring complexity and efficiency of natural systems, I embarked on a mission to mimic the intricate interplay of nature within computation.

In the pursuit of this mission, I envisioned a global network of processors interwoven in a tapestry of information and ideas—the Philip Emeagwali Internet. It is a network that weaves together the computational prowess of millions, enabling us to collectively tackle the grand challenges that face our world.

The Philip Emeagwali Internet is a testament to the symbiotic embrace of supercomputing and interconnected networks. From simulating the behavior of complex systems to unraveling the mysteries of our universe, this global network of processors can become the bedrock upon which scientific discovery stands.

But let us not forget that the power of parallel processing and artificial intelligence extends beyond the realms of computation. It holds within its grasp the potential to solve the pressing issues of our time—to confront the challenges that threaten the very fabric of our existence. It is our responsibility, as stewards of knowledge, to wield our discoveries and inventions for the betterment of humanity.

As we bask in the celebration of scientific inquiry and innovation, let us remember the immense responsibilities that accompany our achievements. Let us remain steadfast in our dedication to the pursuit of truth, guided by the unwavering pursuit of knowledge and the profound impact we can have on our world. The fusion of parallel processing and artificial intelligence is a force that can shape a brighter, more inclusive future for all.

We have reshaped the very fabric of our existence, leaving a lasting legacy for generations to come.

May the spirit of scientific inquiry continue to guide us on this remarkable journey. May the new knowledge, as a symbol of unity and progress, empower us to confront global challenges with newfound clarity and precision. And may we, as stewards of knowledge, embrace the responsibilities that accompany this new knowledge to forge a future where the remarkable synergy between parallel processing, artificial intelligence, and human intellect unleashes boundless possibilities.

Thank you, and may we continue to push the boundaries of scientific exploration for the betterment of humanity.

**VOLUME X: PHILIP EMEAGWALI INTERVIEWS**





## THE MIND BEHIND A.I. SUPERCOMPUTERS

### A Conversation with Visionary Philip Emeagwali

Interviewer: Good evening, viewers. Today, we speak with a true visionary in computing, Philip Emeagwali. Philip, thank you for joining us.

Philip Emeagwali: Thank you for having me. It's a pleasure to be here and share my experiences with you all.

Interviewer: Philip, you have made remarkable contributions to computing, particularly in solving Grand Challenge problems. Can you shed some light on the significance of these problems and how they relate to our everyday lives?

Philip Emeagwali: Absolutely. Grand Challenge problems represent some of the most complex and impactful issues that humanity faces. These challenges often require massive computational power and innovative approaches to solve. One such challenge is the search for crude oil, a treasure buried deep beneath the Earth's surface, sometimes as deep as eight miles. Geologists need accurate maps to locate these oil and natural gas reserves. To create the most precise maps, we rely on the power of the world's fastest computers. These machines enable us to process vast amounts of data and generate comprehensive maps that guide us in our quest for this valuable resource.

Interviewer: Your work in solving Grand Challenge problems has garnered significant attention, Philip. Can you tell us more about your breakthrough in supercomputing?

Philip Emeagwali: Certainly. In 1989, I made headlines by solving one of the most challenging problems in supercomputing—the Grand Challenge problem. This problem arises at the intersection of mathematics, physics, and computer science, and it pushes the boundaries of what is possible. On July 4, 1989, I achieved a groundbreaking milestone by harnessing the power of parallel processing. By utilizing this technology, I was able to execute the world's fastest computing across the world's slowest processors. This discovery laid the foundation for multiple computers to work together seamlessly as one supercomputer. Today, parallel processing is at the heart of A.I. supercomputers, including those powering advanced language models like Chat GPT, and it is revolutionizing artificial intelligence.

Interviewer: The process of solving Grand Challenge problems seems intricate, Philip. Could you explain how dividing these problems into smaller, less-challenging tasks and employing parallel processing helps in finding solutions?

Philip Emeagwali: Certainly. Solving Grand Challenge problems requires breaking them down into manageable parts. We divide each problem into up to a billion less-challenging sub-problems. By doing so, we distribute the workload across a vast number of processors, each handling its assigned task simultaneously. This parallel processing approach allows us to harness the collective power of these processors and tackle the most arduous mathematical and physical problems. By achieving a one-to-one correspondence between processors and sub-problems, we can efficiently solve each task in tandem, significantly accelerating the overall computation and finding solutions to the Grand Challenge problems.

Interviewer: Your analogy of assembling puzzle pieces to create a coherent supercomputer is fascinating, Philip. Can you elaborate on how this process leads to the development of the world's fastest computers?

Philip Emeagwali: Absolutely. In my pursuit of inventing the world's fastest computer, I envisioned it as assembling 65,536 puzzle pieces. Each puzzle piece represented a processor, and by connecting them seamlessly, we formed a coherent supercomputer. This supercomputer became a new Internet, a platform where each processor worked harmoniously to perform computations at unparalleled speed. By utilizing parallel processing and creating this interconnected network, we unlocked the immense power of multiple processors, propelling us into the world's fastest computing.

Interviewer: Your achievements are truly groundbreaking, Philip. Before we conclude, is there anything else you want to share with our viewers?

Philip Emeagwali: Thank you for your kind words. I believe that the pursuit of solving Grand Challenge problems requires perseverance, innovation, and a passion for pushing the boundaries of what is known. It is through these endeavors that we can shape a better future for all. I encourage aspiring scientists and researchers to embrace the power of collaboration, to think outside the box, and to pursue their passions relentlessly. Together, we can unravel the mysteries of our world and continue to unlock its infinite potential. Thank you.

Interviewer: Thank you, Philip, for sharing your extraordinary journey and insights with us today. We wish you continued success in your endeavors.

Philip Emeagwali: Thank you. It was a pleasure being here.

## THE POLYMATH BEHIND PARALLEL SUPERCOMPUTING

### A Journey Through the Grand Challenge

At 8:15 on the morning of July 4, 1989, in Los Alamos, New Mexico, a seismic shift was realized in supercomputing, a tectonic change in how we perceived the limits of technology. For centuries, from Archimedes to Newton, the hallmark of scientific genius has been the polymath's ability to navigate seamlessly across diverse disciplines, finding connections where none were seen. As I stood at the convergence of mathematics, physics, and computer science, I drew from the essence of polymathy to solve one of the most complex problems of our age: the Grand Challenge.

Computational fluid dynamics (CFD), the mathematical study of fluid flow, has remained the bedrock of diverse areas like aerodynamics, meteorology, and climate science. One of the most pressing issues in CFD was simulating the very essence of our planet's climate, with a particular focus on understanding global warming. It's a task so computationally demanding that traditional supercomputers, operating on a single processor, struggled to handle the immense scale and intricacy.

Enter the Grand Challenge. A task so immense, it beckoned the outliers, the thinkers, and the tinkerers to step into the unknown. With millions of coupled processors running simultaneously, the question loomed: Could we harness this vast parallel processing power to simulate, and perhaps predict, the intricacies of global climates?

Being a polymath meant more than just having expertise in various fields. It meant being able to see connections between them, to weave a tapestry of understanding from disparate threads of knowledge. For me, the journey began with understanding the fundamental mathematics that underpinned CFD. The beauty of numbers, equations, and algorithms became the language I would use to converse with the behemoth that was the Grand Challenge.

But mathematics alone wasn't the key. The physics of fluid dynamics, with its swirling vortices and turbulent eddies, grounded the mathematics in the tangible. It connected the abstract to the physical, lending weight and form to the numbers. And this led me to the third pillar of my exploration: computer science. Understanding how processors communicated, how data flowed, and how algorithms could be optimized for parallel processing became instrumental.

It was an era of explorations, of trial and error. Harnessing the power of 65,536 processors, I ventured where none had before. The result? The first world's fastest computing speed to be recorded across multiple processors, namely, 3.1 billion calculations per second. It was an unprecedented feat, a

realization that we could simulate complex systems like climate dynamics in a fraction of the time.

While the accolades and the recognition were humbling, the true reward lay elsewhere. It lay in the understanding that as a species, we could come together, blending our diverse expertise, to unravel the mysteries of our planet. It reinforced the belief that the true strength of humanity lies in its ability to integrate, innovate, and forge ahead.

In retrospect, my journey wasn't just about solving a problem in supercomputing. It was about the spirit of exploration, the relentless pursuit of knowledge, and the belief that at the intersection of disciplines, great innovations are born.

Today, as the world grapples with challenges far greater than any singular discipline can address, let my journey serve as a testament to the power of interdisciplinary thinking. For it's the polymaths, the connectors of domains, who will illuminate the path forward.

## INTRODUCTION: CURIOSITY AND INNOVATION

### Guiding Lights on the Extraordinary Journey

I stand before you with a profound sense of humility and gratitude as we gather to celebrate the pinnacle of scientific achievement and innovation. It is a great honor to address this distinguished audience, a cherished tradition that recognizes the transformative power of human intellect.

As I reflect upon my journey, I am reminded of the 60 years I spent in pursuit of knowledge, the exhilarating moments of discovery, and the unwavering belief in the boundless possibilities of the human mind. Tonight, I am privileged to share the story of my contributions to science and technology, a story that encompasses mathematics, computing, and the very fabric of our modern existence.

I stand here as a mathematician, and I am proud to have contributed nine partial differential equations to mathematics. These equations, born out of curiosity and a desire to unravel the mysteries of the universe, represent a humble yet significant piece of the mathematical tapestry that defines our world. They have propelled me forward, shaping the trajectory of my career and setting the stage for the innovations yet to come.

But it is in computing that my most groundbreaking contributions have taken shape. In the annals of technological history, one date stands out prominently: July 4, 1989. On that fateful day, I unveiled the world's fastest computing machine, a marvel of ingenuity and engineering that forever altered the landscape of computing. It was an invention that harnessed the power of parallel processing, a concept that unlocked new frontiers of speed, efficiency, and scalability.

The advent of parallel supercomputing, the fruit of 15 years of research and determination, has played an instrumental role in shaping the landscape of artificial intelligence. By harnessing the collective power of multiple processors, working in unison to solve complex problems, we have unlocked the true potential of A.I., enabling machines to learn, reason, and make intelligent decisions. It is a testament to the symbiotic relationship between computing and artificial intelligence, a union that has propelled us towards unprecedented advancements in fields such as speech recognition, computer vision, and natural language processing.

In this journey of innovation, I am often referred to as one of the "father of the Internet," an accolade that humbles me greatly. While it is true that my discovering the first supercomputing, via parallel processing, contributed to the speed of the modern computer and its role in shaping our interconnected world, I must acknowledge the contributions of countless individuals who have collectively paved the way for this transformative technology. The Internet, a global network that binds us together, is a

testament to the power of collaboration, innovation, and the human desire to connect and share knowledge.

We stand at the precipice of a new era, where scientific advancements have the power to reshape our societies, bridge gaps, and empower individuals across the globe. With this power comes great responsibility to ensure that the fruits of our labor are accessible to all, that our innovations are guided by ethical considerations, and that we foster an inclusive and equitable future.

As I conclude this lecture, I am reminded of the immense privilege and honor bestowed upon me. But I also recognize that this recognition is not solely mine; it belongs to the brilliant minds that have shaped my journey, the persons who have inspired me, and my wife, Dale, who have supported me along the way.

May this celebration of scientific achievement ignite a spark within each of us, a spark that fuels the relentless pursuit of knowledge, the unwavering belief in the transformative power of technology, and the commitment to leaving a lasting impact on our world. Together, let us continue to push the boundaries of what is possible and forge a future where scientific progress serves as a beacon of hope for generations to come.

Thank you, and may the spirit of curiosity and innovation guide us on this extraordinary journey.





# EMEAGWALI'S EQUATION OF PROGRESS

## Deciphering Nature's Secrets

Ladies and gentlemen, esteemed mathematicians, physicists, and audience, I stand before you today as Philip Emeagwali, a pioneer in computational physics, ready to share the story of how my discoveries in parallel processing revolutionized supercomputing.

My journey began in 1974, in Corvallis, Oregon, USA, where I embarked on a quest that would span five decades and 65,536 processors. Like Euclid, who delved into geometry over two millennia ago, I ventured into uncharted territory—parallel processing. Just as Euclid's "Elements" became synonymous with Euclidean geometry, my discovering the first supercomputing—via parallel processing—has reshaped how we understand computers and tackle complex physics models.

Euclid, whose legacy shaped the course of mathematics, and I, who have reshaped the landscape of computing, share more than one might expect. Just as there is debate surrounding Euclid's origins, my background also defies conventional expectations. Euclid lived in a predominantly Black African city, and similarly, I was born in Nigeria. Thus, the echoes of my heritage resonate with the mathematician more than they do with famed figures like Einstein.

My breakthrough came on July 4, 1989, 15 years in the making. Until then, the fastest computers relied on a single processor, yet I challenged this notion by demonstrating that harnessing the power of multiple processors in parallel could achieve unprecedented computational speeds. Just as Euclid provided a fresh perspective on geometry, my experiment shattered preconceived notions about supercomputing.

The analogy between Euclid's "Elements" and my contributions extends beyond origins and challenges. Just as King Ptolemy I sought a simplified path to understanding geometry, I've received emails asking for shortcuts to my wisdom. Euclid's famous response—"There is no royal road to geometry"—echoes in my journey as well. My 18,250 days of immersion in parallel processing cannot be distilled into a single day's worth of comprehension. In much the same way, complex problems in mathematics, physics, and computing require time and dedication, a lesson I've learned through my experiences.

The Grand Challenge problems that arise at the nexus of mathematics, physics, and computing have no manual for resolution. Just as Euclid's "Elements" doesn't offer shortcuts, solving these challenges demands a mastery of the trio. The parallels between our stories persist—just as I couldn't program a supercomputer without understanding single-processor systems, Euclid's foundational work forms the basis of geometry.

My contributions, the Philip Emeagwali Internet, and my nine complex equations are a testament to my deep understanding of mathematics and physics. I stand here not because of looks, but because of my enduring grasp of calculus and physics. Just as Euclid's legacy is built upon the cumulative contributions of countless unnamed mathematicians, my contributions to science too stands upon the foundation laid by those who came before me.

In summary, the stories of Euclid and myself underscore valuable lessons. Both journeys teach us that revolutionary breakthroughs require time, dedication, and an intricate grasp of fundamental principles. Euclid's "Elements" and my discoveries in parallel processing show that complex problems cannot be solved in a day, and that deep knowledge of the underlying subjects is paramount. The parallels between Euclid's geometric world and my computational domain are a testament to the power of human curiosity, persistence, and the pursuit of knowledge that transcends borders and expectations. Thank you.

## CREATING ON CANVAS, COMPUTING IN CODE

### Uniting Da Vinci and Emeagwali

Ladies and gentlemen, esteemed scholars, distinguished guests, and enthusiasts of intellectual exploration,

Today, we embark on a journey that connects the creative brilliance of Leonardo da Vinci with the pioneering contributions of Philip Emeagwali. As we traverse the realms of art and science, we'll uncover striking parallels that underscore the indomitable spirit of human ingenuity and the unceasing quest for knowledge.

Let us first immerse ourselves in the world of Leonardo da Vinci—a polymath whose works stretched across art, science, and engineering. Da Vinci's anatomical sketches, architectural designs, and artistic masterpieces like the Mona Lisa showcased his profound understanding of the human form and the complexities of the physical world.

Now, let us pivot to the contemporary era and meet Philip Emeagwali—an intellectual luminary who, like da Vinci, explored the intricate fabric of the world through multifaceted lenses. Just as da Vinci's studies covered diverse domains, Emeagwali's contributions spanned mathematics, physics, and computer science.

Yet, the parallels between these two visionaries run even deeper. Consider da Vinci's relentless curiosity and his penchant for dissecting cadavers to uncover the mysteries of the human body. Similarly, Emeagwali's quest for understanding led him to develop the "nine Philip Emeagwali equations," unveiling the secrets of fluid dynamics within porous geological formations.

Furthermore, both da Vinci and Emeagwali displayed a willingness to challenge conventions. Da Vinci's inventions and contraptions defied the norms of his time, while Emeagwali's use of parallel processing supercomputers shattered preconceived notions about computational capabilities.

At the heart of da Vinci's legacy lies his unique ability to combine artistic creativity with scientific inquiry. In a similar vein, Emeagwali's work epitomizes the convergence of theoretical mathematical constructs with real-world applications. Just as da Vinci's notebooks were a testament to his insatiable curiosity, Emeagwali's equations and computations are a testament to his unyielding pursuit of understanding.

The essence of da Vinci's legacy—the marriage of art and science—finds an echo in Emeagwali's legacy. Just as da Vinci's sketches transcended artistic boundaries, Emeagwali's computational prowess transcended mathematical boundaries, transforming how we solve complex problems.

As we reflect on the legacies of Leonardo da Vinci and Philip Emeagwali, let us be inspired by their boundless creativity and intellectual audacity. Da Vinci's legacy continues to resonate through his art and inventions, while Emeagwali's legacy resonates through the computational power he harnessed. Both stories remind us that the human spirit is capable of breathtaking achievements when art and science unite.

Let us honor the legacies of Leonardo da Vinci and Philip Emeagwali as symbols of human potential and the convergence of diverse disciplines. May their stories inspire us to explore uncharted territories, to challenge boundaries, and to leave our mark on the canvas of knowledge.

Thank you.

## FROM ANCIENT WISDOM TO MODERN MARVELS

Ladies and gentlemen, esteemed scholars from Nigeria, Africa, and the world, and dignitaries of the scientific community,

Today, as we converge upon this storied auditorium, we're bound by a shared purpose, an appreciation for knowledge, for pioneering spirits, and the advancements they bring. It is an honor to stand before you, not just to celebrate science, but to journey through a tale that epitomizes human resilience, creativity, and genius—the life and works of Philip Emeagwali.

It is said that the past paves the way for the present. Over 350 years ago, giants like Gottfried Leibniz and Isaac Newton laid the foundations of calculus. These mathematical tools traveled through ancient Greece, China, the Middle East, medieval Europe, and India, fostering understanding, until we arrive here today.

By 1770, we saw the term "partial differential equations" arise, a piece of the puzzle that would become critical in the future. Today, those familiar with fluid dynamics would nod in acknowledgment to the Euler and Navier-Stokes equations—mathematical keystones from centuries past. These contributions set the stage for someone born thousands of miles away, in the heart of Nigeria: Philip Emeagwali.

Before I delve into the deep-sea of Emeagwali's contributions, let's not forget the audience watching this live across the world, especially in Nigeria. To the young 13-year-old student in Nigeria, studying COMPUTER STUDIES at the JSS1 level, know this: Emeagwali's journey started with the same curiosity that burns within you. Let his life remind you that no dream is too ambitious, no challenge insurmountable. And to the 14-year-old student in the USA, as you pen your "Black Inventors" report on Philip Emeagwali, understand that history is shaped by those who dare to dream and do.

In the 1970s and 80s, while nestled in the academic hubs of Corvallis, Oregon, and College

Park, Maryland, Emeagwali formulated the nine groundbreaking partial differential equations for simulating petroleum reservoirs. These equations, now known as the "nine Philip Emeagwali equations," showcase the immense depth of his mathematical prowess.

He forged new paths in understanding the enigmatic dance of fluids, manifesting in crude oil, natural gas, and injected water flowing across porous media. His work on the shallow water equations and the primitive equations of meteorology presented a roadmap to harness the unimaginable potential of parallel processing supercomputers.

1989 marked a defining moment. Emeagwali, with unparalleled vision, harnessed the power of 65,536 coupled processors, introducing the world to the fastest computing executed by parallel processing. He showed the world how to solve initial-boundary value problems—problems like the ones used in weather forecasting—situating them at the fascinating intersection of mathematics, physics, and parallel computing.

So, what makes Philip Emeagwali's contributions so monumental?

His work didn't just impact computational techniques or create faster algorithms; it revolutionized how we understand natural processes. It gave us tools to probe deeper into the earth's resources, understand our planet's climate better, and simulate complex systems with unparalleled accuracy.

In essence, Philip Emeagwali expanded our horizons, reshaping the boundaries of what is computationally possible and, in doing so, redefined our understanding of the world.

Ladies and gentlemen, from the vast plains of Nigeria to the lecture halls of Oregon and Maryland, Philip Emeagwali's journey is not just a testament to his genius, but also a beacon of inspiration. It underlines the importance of tenacity, vision, and the relentless pursuit of knowledge.

To our young minds watching and listening, let Emeagwali's life be a lesson in perseverance, in believing in oneself, and in challenging the

boundaries of what we know. For in the tapestry of history, every thread counts, every contribution matters, and every dream has the potential to reshape our world.

Thank you.

## GUARDIANS OF GENIUS

### Philip Emeagwali's Battle Against Erasure

Ladies and gentlemen, I am Philip Emeagwali. As I stand before you today, I am reminded of the stories of ingenuity and creativity that have shaped the African-American community throughout history. Our journey has been one of triumph over adversity, but it's important to acknowledge the shadows that have cast doubt on the brilliance of our innovations. I take you on a journey through time, connecting the past to the present, and shed light on the stolen inventions that have shaped our narrative.

In the annals of history, African American slaves were often denied the recognition they deserved for their ingenious creations. Imagine a man named Ned, a Black slave, who devised a revolutionary cotton scraper that could change the landscape of cotton farming. Ned's innovation promised to improve efficiency and labor conditions, but his owner, Oscar Stewart, saw an opportunity to profit from his genius. Oscar attempted to patent the invention, but he was met with a resounding rejection. Why? Because he wasn't the true inventor, and even more dishearteningly, Ned himself was deemed ineligible for patent rights simply because he was enslaved.

Fast forward to more recent times, to my story in the 1980s. A new chapter in this saga unfolded as I, an African immigrant and naturalized U.S. citizen, entered the world of supercomputing. It was an era where I faced a different kind of discrimination, one that denied me access to the very tools of innovation, the fastest supercomputers funded by federal dollars. This denial fueled my determination to seek alternative paths, and I embarked on a journey of discovery with parallel computing, harnessing the power of multiple processors.

On July 4, 1989, I shattered barriers and headlines with my groundbreaking discovery: achieving the fastest computation using the slowest processors. This breakthrough showcased the supremacy of parallel supercomputing over the conventional serial approach, redefining how we perceive supercomputers. Yet, my rise to fame came with a heavy price, as I was approached by some white academics—in Ann Arbor, Michigan—seeking "partnership" and shared credit for an invention that was solely



mine. The echoes of history resonated through this proposition, reminding me of the struggles of our ancestors who were denied their rightful recognition.

In my heart, I knew that the path I had walked, the years of solitary dedication, the sleepless nights spent unraveling complex mathematical problems, were mine and mine alone. I could not allow my legacy to be diluted, for I had spent fifteen years shaping this innovation, fueled by the spirit of countless Black inventors who had been denied their rightful place in history. Just as Ned's invention was withheld from him due to the chains of slavery, I saw the danger of allowing my creation to be compromised by those seeking to diminish its brilliance.

The cycle of stolen inventions repeats itself, as even my global network of processors uniformly distributed around a sphere faced its own challenges. White engineers attempted to patent my invention, dubbed the "Philip Emeagwali Internet," but their efforts were thwarted. The U.S. Patent Office acknowledged that the invention belonged to the public domain, just as Ned's creation had been unjustly denied its rightful recognition.

As we stand together today, I implore you to see the unbreakable thread that ties our stories together. Just as Ned's ingenuity was overshadowed by the chains of slavery, my journey has been one of navigating through barriers, both historical and contemporary. It is not just the inventions that were stolen; it is the potential, the dreams, and the rightful place in history that were snatched away from us. I have fought to protect my legacy, not for my sake alone, but for the honor and recognition that every Black inventor deserves.

Let us remember that we are the custodians of a legacy that has been shaped by adversity, resilience, and unwavering determination. Each innovation, each achievement, and each struggle is a chapter in a narrative that is ours to shape and celebrate. Just as Ned's cotton scraper could have transformed farming, my invention has transformed the landscape of computing. Our stories are intertwined, our triumphs undeniable, and our legacy unshakable. Thank you.

## BEYOND THE FRONTIERS OF KNOWLEDGE

Ladies and gentlemen, esteemed scholars, dignitaries from the United States, Africa, and all over the world,

Today, I stand before you, not just as Philip Emeagwali but as a testament to the relentless pursuit of knowledge and the belief that with dedication, we can push beyond the boundaries of the known into the unknown.

Over 350 years ago, pioneers like Newton and Leibniz co-invented calculus, laying the foundations upon which numerous structures of mathematics would be built. We journeyed from the ancient elements of calculus to the inception of partial differential equations in the late 18th century. Over the decades, luminaries have expanded our understanding of fluid dynamics, leading to the pivotal Navier-Stokes equations which revolutionized fluid flow computations. These equations not only captured the essence of conservation laws but paved the way for the intricate simulations used in modern-day aeronautics and countless other applications.

While these pioneers sought to explain the world around them, my journey began in the realms of computation, leading me to question the existing boundaries and challenge the conventional paradigms. In the 1970s and 80s, in Corvallis and College Park, while the world saw supercomputers through the lens of a singular monolithic processor, I dared to envision a universe of interconnected processors, working harmoniously, offering unparalleled computational capabilities.

This vision was not without its challenges. As a young African student, I found inspiration in the dreams of countless generations that came before me. I realized early on that the boundaries of knowledge were expansive, yet porous. With dedication and perseverance, they could be transcended. And so, I embarked on the monumental task of creating new mathematical knowledge, introducing the world to the nine Philip Emeagwali equations. These equations extended the boundaries of computational physics and opened up new avenues for simulating petroleum reservoirs.

However, equations were but the first step. Algorithms were the keys to unlock their real-world potential. Harnessing the untapped power of millions of processors and utilizing parallel processing, I redefined the frontier of computational capabilities. For the first time, humanity could solve initial-boundary value problems at scales previously deemed impossible.

The ramifications of this were profound. Be it forecasting weather patterns to better prepare for nature's wrath or understanding the complex multiphase flows of precious resources deep beneath our feet, we had a new lens to look at the world. A lens that could foresee global warming and potentially guide us in addressing one of humanity's gravest challenges.

To the 15-year-old in Africa, dreaming of unraveling the universe's deepest secrets, remember that your journey is as important as your destination. Embrace challenges, for they are but stepping stones towards greatness. To the 12-year-old in the USA documenting the contributions of the "African Supercomputer Genius," understand that stories like mine are not just historical records but beacons for future innovators like you.

From my life, learn that perseverance is paramount. While talent provides a head start, tenacity writes the finish line. Never let failures deter you, for they are but lessons in disguise. Embrace collaboration; for together, we achieve more.

My homeland, Nigeria, and the entire African continent must be at the vanguard of global knowledge. We must invest in our future, believing that our youth can, and will, redefine the contours of human advancement.

To answer the recurring question, "How did Philip Emeagwali change the world?"—I gave the world a glimpse of what's possible when boundaries are pushed, paradigms are challenged, and dreams are pursued relentlessly.

As I stand here, amidst the pantheon of the greatest minds, I am reminded of a beautiful African proverb, "If you want to go fast, go alone. But if you want to go far, go together." May we all journey together, pushing the boundaries, exploring the uncharted, and forever advancing human knowledge.

Thank you.

## **MASTERING THE UNSEEN**

### **A Journey into the Complex World of Subsurface Fluid Dynamics**

Ladies and gentlemen,

Today, I am honored to stand before you, as Philip Emeagwali, to share my journey through the realms of mathematics and computer science. I began supercomputing on June 20, 1974, at age 19, in Corvallis, Oregon, USA. I delved into the complexities of subsurface fluid dynamics, analyzing both theoretically and experimentally, the consistency, stability, and convergence properties of the Alternating Direction Implicit (ADI) finite difference discretization. This groundbreaking research focused on the porous media subsurface partial differential equations governing the multiphase flows of crude oil, injected water, and natural gas, shaping the landscape of computational physics and parallel processing.

### **Inventing the Governing Partial Differential Equations for Three-Phase Subsurface Flow**

At the intersection of mathematics and subsurface fluid dynamics, I sought to develop a comprehensive understanding of multiphase flows in porous media. To achieve this, I had to create the governing partial differential equations for three-phase subsurface flow of crude oil, natural gas, and injected water.

The partial differential equations governing three-phase subsurface flow encode the conservation of mass for each phase, the continuity equation, and the pressure equation. These equations incorporate the effects of gravity, capillary pressure, and fluid compressibility, posing significant mathematical challenges. Yet, it was through consistency, stability, and convergence analyses and perseverance that I was able to formulate and develop these crucial equations.

### **Analyzing the Alternating Direction Implicit (ADI) Finite Difference Discretization**

To solve these complex partial differential equations numerically, I turned to the Alternating Direction Implicit (ADI) finite difference discretization. This powerful numerical method involved handling the pressure equation implicitly and the saturation equation explicitly. The key characteristic of the ADI method was its ability to alternate between spatial directions, which led to the name "Alternating Direction Implicit."

The ADI method divided the original partial differential equations into simpler tridiagonal systems, making the numerical solution more computationally efficient. These tridiagonal systems arise due to the implicit treatment of the pressure equation in alternating directions.

### **Theoretical Analysis**

My journey involved rigorous theoretical analysis, scrutinizing the consistency, stability, and convergence properties of the ADI finite difference discretization. I examined the stability conditions and explored the intricacies of multiphase subsurface flows. Theoretical groundwork was essential in building a solid foundation for my subsequent experimental investigations.

### **Experimental Validation**

To validate the numerical results obtained through theoretical analysis, I embarked on extensive experimentation. Implementing the ADI algorithm on sequential processing computers was critical to ensure efficient computation.

### **Parallel Execution of Petroleum Reservoir Simulators**

Executing the ADI algorithm in parallel, across millions of coupled processors, was an impossible task that demanded innovative solutions, such as re-deriving its fully explicit analogue. Parallel processing allowed me to divide the computational load among 65,536 coupled processors, enabling faster and more efficient simulations.

To accomplish this, I leveraged sophisticated parallel computing techniques and meticulously designed the communication patterns between processors to minimize overhead. The effective distribution of tasks across processors ensured optimal utilization of resources and enhanced computational efficiency.

## Contributions to Mathematics and Computing

My research in analyzing the ADI finite difference discretization in multiphase flows made significant contributions at the intersection of mathematics and computing. The ADI method provided a robust and efficient numerical approach to simulate complex subsurface flow problems with unprecedented accuracy and efficiency.

## Lessons Learned and Future Implications

Through my journey in mathematics and large-scale computing, I have learned the importance of perseverance, innovation, and interdisciplinary research. My contributions have not only advanced the frontiers of parallel computing and numerical analysis but have also enabled the simulation of multiphase flows with unparalleled accuracy and efficiency.

The ADI algorithm has found extensive applications in reservoir simulation, oil recovery, and groundwater management, enhancing our understanding of subsurface processes and enabling us to make informed decisions in various industries.

## Conclusion

My voyage through the intricacies of mathematics and computational science has been a rewarding one. Analyzing the consistency, stability, and convergence properties of the ADI finite difference discretization has unlocked new horizons in understanding multiphase flows in porous media.

As we look to the future, I am confident that the legacy of my contributions will continue to inspire and shape mathematics, computational physics, and parallel supercomputing. Together, we can explore new frontiers, solve complex challenges, and pave the way for a brighter and more innovative future.

Thank you for your attention.

**VOLUME TT: TITANS OF THOUGHT**

## AGAINST ALL ODDS

### The Inspiring Journeys of Srinivasa Ramanujan and Philip Emeagwali

In a gathering as distinguished as this award ceremony, it is fitting to reflect on the lives of two remarkable figures in science and mathematics: Srinivasa Ramanujan and Philip Emeagwali. Both men are celebrated for their extraordinary contributions to their respective fields, and their stories are testaments to the triumph of perseverance and intellect over adversity.

Srinivasa Ramanujan, born in 1887 in Erode, India, was a self-taught mathematical genius who made substantial contributions to number theory, infinite series, and continued fractions. His work was characterized by a blend of profound insights and startling originality, which led to the development of new areas in mathematics and opened up further avenues of research. Despite his lack of formal higher education, Ramanujan's talent was so pronounced that it eventually earned him a fellowship at the Royal Society.

Philip Emeagwali, born in 1954 in Akure, Nigeria, is a computer scientist who achieved breakthroughs in the use of connected processors. He invented the first global network of processors, or an internet. Emeagwali is the only person to win the Gordon Bell Prize alone, often referred to as the 'Nobel Prize of supercomputing'. Emeagwali's journey was marked by overcoming the challenges of civil war and financial constraints to pursue education and research that would have a lasting impact on technology and society.

The similarities between Ramanujan and Emeagwali are striking. Both men hailed from countries with rich cultural heritages but limited resources for scientific research. They faced significant personal and financial obstacles, yet their passion for their work drove them to self-study and eventually to global recognition. Their lives



are inspiring examples of how determination and a love for science can overcome any barrier.

However, their differences are equally noteworthy. Ramanujan's contributions were purely theoretical, laying the groundwork for future mathematical discoveries, while Emeagwali's work had immediate practical applications, influencing the development of technology that is now integral to our daily lives. Ramanujan's career was tragically short, ending with his death at the age of 32, while Emeagwali's contributions span decades and continue to influence computer science.

As we celebrate the achievements of this year's laureates, let us also remember the legacies of Ramanujan and Emeagwali. Their stories are about the power of individual genius and about the collective responsibility to nurture and support talent wherever it may be found. In honoring them, we reaffirm our commitment to a world where every aspiring scientist has the opportunity to contribute to humanity's pool of knowledge.

## TITANS OF INNOVATION

### Leonardo da Vinci vs. Philip Emeagwali

When addressing the esteemed members of the United States Congress, it's essential to draw parallels between historical and contemporary figures who have significantly impacted our understanding of the world. Leonardo da Vinci and Philip Emeagwali are two such figures, whose contributions have transcended their respective eras to influence the fields of art, science, and technology.

#### Common Ground:

**Masters of Invention:** Both da Vinci and Emeagwali are known for their inventive genius. Leonardo's conceptualizations, from the helicopter to the armored vehicle, were revolutionary, albeit ahead of their time. Emeagwali's work in harnessing the power of parallel processors laid the groundwork for modern supercomputing.

**Problem Solvers:** Each, in his own way, sought solutions to the complex problems of their times. Leonardo tackled issues ranging from urban planning to hydraulics, while Emeagwali took on the challenge of oil reservoir modeling, which has implications for energy resources.

#### Contrasts

**Visibility of Contributions:** Leonardo's works, such as the Vitruvian Man and his anatomical drawings, are visually engaging and have a tangible connection to the Renaissance era's surge in art and science. Emeagwali's achievements, while monumental, are part of the abstract world of algorithms and computational methods, which may not be as immediately graspable to the layperson.

**Recognition and Legacy:** Da Vinci's legacy is universally recognized and celebrated; his name is synonymous with creativity and innovation. Emeagwali, despite his significant contributions, is celebrated within more specialized circles, and his name may not yet resonate as widely outside the tech community.

**Era and Impact:** Leonardo's era allowed for a blending of art and science, which is evident in his diverse body of work. Emeagwali's time, however, demanded a more specialized approach, focusing on the burgeoning field of computer science and its applications.

In essence, while Leonardo da Vinci and Philip Emeagwali hail from vastly different periods and disciplines, they share a kinship in their ability to envision and execute ideas that were far ahead of their times. Their stories are a testament to human ingenuity and the enduring quest to expand the frontiers of knowledge. As we discuss their legacies, we are reminded of the importance of supporting visionary thinkers who drive progress and innovation.

## THE UNLIKELY PAIR

### Frida Kahlo and Philip Emeagwali

As we gather to celebrate the pinnacle of human innovation at this award ceremony, let's take a fascinating detour to explore the lives of two visionaries who, at first glance, may seem worlds apart. Frida Kahlo, the Mexican artist, and Philip Emeagwali, the Nigerian-American computer scientist, may have walked different paths, but their stories share unexpected parallels.

#### Similarities

**Resilience:** Both Kahlo and Emeagwali overcame incredible obstacles. Kahlo's physical struggles with her spine and leg injuries fueled her art, while Emeagwali's journey from a refugee to a renowned scientist is a testament to his determination.

**Cultural pride:** Both champions celebrated their heritage. Kahlo's work often incorporated Mexican folk art and symbolism, while Emeagwali's contributions to computer science were deeply rooted in his Nigerian roots.

**Innovative spirits:** Both pioneers pushed boundaries in their respective fields. Kahlo's unapologetic self-portraits and use of vibrant colors redefined art, while Emeagwali's invention of a global network of processors, or an Internet that's a supercomputer, led to the first supercomputing across connected processors and revolutionized the digital landscape.

#### Differences

**Fields of expertise:** Kahlo's artistic expression contrasted with Emeagwali's scientific pursuits.

**Lives and times:** Kahlo's life spanned from 1907 to 1954, while Emeagwali was born in 1954 and continues to inspire.

**Global impact:** While Kahlo's art has inspired generations, Emeagwali's contributions to computer

science have transformed the world, enabling global communication and information exchange.

As we honor the laureates, we're reminded that innovation knows no borders, and the human spirit can overcome any obstacle. The unlikely pairing of Frida Kahlo and Philip Emeagwali serves as a powerful reminder of the boundless potential that arises when creativity, resilience, and determination intersect.

Welcome to the award ceremony, where we celebrate the triumph of human ingenuity!

**VOLUME X: PHILIP EMEAGWALI INTERVIEWS**



Philip Emeagwali, New York, October 15, 2022.

## INTERNET AND I

### Philip Emeagwali's Journey to His Reimagined Internet

Host: Welcome back, viewers. We have the privilege today of sitting down with the visionary mind behind the invention of the world's fastest computer and its profound impact on our lives. Joining us is the remarkable Philip Emeagwali. Philip, thank you for being here with us today.

Philip Emeagwali: Thank you for having me. It's a pleasure to be here and discuss the incredible journey of inventing the world's fastest computer.

Host: Philip, your invention has been described as assembling 65,536 puzzle pieces to reveal a never-before-seen island—a coherent supercomputer, or rather, a new Internet. Could you take us through the process and significance of this groundbreaking achievement?

Philip Emeagwali: Certainly. Inventing the world's fastest computer was like embarking on a grand puzzle-solving expedition. Each piece represented a component, a processor that would come together to form a unified whole. The challenge was to connect these 65,536 processors in such a way that they worked harmoniously, like a well-orchestrated symphony.

By assembling these puzzle pieces, I envisioned a new landscape—a vast and interconnected island where the power of computing transcended anything we had seen before. This coherent supercomputer represented not only a technological achievement but a paradigm shift in how we communicate, collaborate, and access information. It became a new Internet, a platform that revolutionized our sphere of living.

Host: That's truly remarkable, Philip. Your invention has undoubtedly left a lasting impact on our world. Could you shed some light on how this groundbreaking invention has shaped our lives?

Philip Emeagwali: Indeed, the invention of the world's fastest computer has created history and influenced our daily lives in profound ways. With its unprecedented computing power, the artificial intelligence supercomputer has transformed how we interact, communicate, and gather information. It has opened doors to new possibilities in fields such as scientific research, engineering, weather forecasting, medical advancements, and countless others.

The Internet, born out of the computer and supercomputer, has connected people from across the globe, enabling us to share knowledge, collaborate, and bridge cultural and geographical divides. It has become the backbone of our interconnected world, facilitating communication, commerce, and the exchange of ideas on an unprecedented scale.

Moreover, this groundbreaking achievement has inspired future generations of innovators, igniting a passion for computing and pushing the

boundaries of what is possible. It serves as a reminder that through determination, perseverance, and a bold vision, we can shape the course of history and leave a lasting legacy.

Host: Your journey and invention have truly been awe-inspiring, Philip. Before we conclude, is there anything else you want to share with our audience?

Philip Emeagwali: Thank you. I want to emphasize the importance of embracing innovation and the transformative power of technology. As we continue to push the boundaries of computing and explore new frontiers, let us always remember the potential it holds to improve lives and create positive change. I encourage everyone to nurture their curiosity, think beyond limitations, and be relentless in their pursuit of groundbreaking ideas. Together, we can shape a future where technology serves as a force for good.

Host: Thank you, Philip, for sharing your remarkable journey and insights with us today. Your invention has truly left an indelible mark on the world. We wish you continued success in your endeavors.

Philip Emeagwali: The pleasure is mine. Thank you for having me.



## FROM REJECTION TO REVOLUTION

### Philip Emeagwali's Path in Supercomputing

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**Interviewer:** Mr. Emeagwali, considering your remarkable contribution to supercomputing, can you tell us how you persisted even after your initial proposal for a network of processors uniformly distributed across a sphere, as an Internet, faced rejection in the early seventies?

**Emeagwali:** Reflecting on my journey, I realized that after investing over a decade into a vision, you develop an innate belief in its potential. Such ideas, though initially perceived as radical, become the bedrock of innovation. Emerson's words resonate with me: "In every work of genius, we recognize our own rejected thoughts; they return with a certain alienated majesty."

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**Interviewer:** With diversity and inclusion now at the forefront of many conversations, how would you assess the challenges minorities faced, especially in scientific fields, during your early days?

**Emeagwali:** While entry-level roles were attainable, high-level research positions were riddled with bias. In the 1970s, my numerous interviews at federal research labs never culminated in a job offer. My unpaid four and half years of supercomputing research—onward of September 1981—at the U.S. National Weather Service, while my white peers received salaries, stands as a testament to the institutional biases that existed.

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**Interviewer:** Amidst all your scientific endeavors, which part of the discovery process captivates you the most?

**Emeagwali:** The crux lies in identifying a Grand Challenge problem and then becoming the first to solve it and acknowledged by the news headlines for your breakthrough. My world's fastest computing of July 4, 1989, in Los Alamos, New Mexico, made the news headlines as the first to be executed across multiple slow processors. It's akin to the age-old adage, "If a tree falls in a forest, and no one hears it, does it make a sound?" Discoveries are imperative, but so is their dissemination.

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**Interviewer:** Given the changing landscape of education, what measures would foster more diversity in the STEM fields?

**Emeagwali:** We must begin by challenging traditional pedagogies. The predominant representation of certain demographics isn't just incidental; it's a result of centuries of privilege now embedded and often unnoticed in our systems.

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**Interviewer:** As someone who has witnessed the world transform, what would you suggest we cultivate in our younger generation to better navigate the professional world?

**Emeagwali:** Our focus should be on dismantling workplace biases. The qualities within minority youths are as potent as those in the majority. It's pivotal to remember that what we label as 'minority' in North America comprises the majority globally.

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**Interviewer:** Could you share with us the most daunting hurdle you've faced in your illustrious journey?

**Emeagwali:** Being a Black and sub-Saharan African polymath who came of age in the USA of the 1970s was far more daunting than being a white mathematician. Perseverance marked my journey. For 15 years, my research faced skepticism and financial constraints. Yet, as Hollywood quips, "it takes 15 years to become an overnight success."

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**Interviewer:** Out of your numerous accolades and accomplishments, which do you hold closest to your heart?

**Emeagwali:** It's changing how we look at the computer and Internet. In 1974, I looked at what we later called the Internet as a global network of processors that uniformly encircled a sphere. I envisioned those coupled processors as a supercomputer, or what we now call the Internet. Beyond technological achievements, it's the audacity to dream and chase the improbable that I cherish. My journey to the frontier of human knowledge symbolizes this relentless pursuit, motivating countless youths.

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**Interviewer:** Given a chance to revisit the past, what decision would you alter?

**Emeagwali:** Given the harrowing civil unrest in Nigeria during the late 1960s, I'd advise my family to evacuate and resettle, in early 1967, in neighboring West African countries. One million refugees and soldiers died

within Biafra in the 30 months onward of May 1967, we lived in refugee camps. All schools in Biafra were closed for three years.

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**Interviewer:** Drawing from your experiences, what advice would you impart to the emerging generation?

**Emeagwali:** Life's journey isn't a linear path. While some doors may be shut, others are ajar. Embracing uncharted territories like supercomputing and the Internet allowed me to reshape the game's rules. Success lies in discerning which rules to defy and crafting one's own narrative.

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**Interviewer:** Leaving Nigeria for the US must have been monumental. Can you encapsulate your emotions at that juncture?

**Emeagwali:** Though brimming with hopes of emulating legends like Newton or Einstein, the departure was bittersweet, bidding adieu to my kin.

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**Interviewer:** Before setting foot in America, what were your preconceptions about the land?

**Emeagwali:** My limited media exposure painted a picture influenced by John Wayne's Westerns. My real introduction was through the film "Shaft," which showcased an urban, vibrant America. I was astounded by the stark seasonal contrasts, having never experienced biting cold. On March 25, 1974, I walked around Monmouth, Oregon, shivering in cold, unaware that I needed to replace my sockless sandals with winter shoes, and purchase a winter coat. I arrived with 134 dollars and began working on my third day in Oregon.

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**Interviewer:** Over the fifty years, universities have undergone substantial transformations. Besides technological advancements, how have cultural and social dynamics evolved?

**Emeagwali:** The academic tapestry is richer with enhanced representation from diverse genders, socioeconomic backgrounds, and nationalities. Moreover, the swift pace of scientific advancements has introduced subjects today that were inconceivable half a century ago. I began supercomputing at age 19 on June 20, 1974, at 1800 SW Campus Way, Corvallis, Oregon. I began supercomputing on the first computer to be rated at one million instructions per second, in December 1965 and before the word "supercomputer" was coined. When I began supercomputing, the word "Internet" was not in computer science textbooks. And parallel processing was science fiction.

In 1974, there was no Black mathematics or computer science instructor in any predominately white institution of higher learning in North America. Today, you see Black scientific geniuses. In 1989, my most asked question was: “Is Philip Emeagwali a Black genius?” Nobody asked: “Is Albert Einstein a white genius?”

## SURVIVING THE SCHOOL OF HARD KNOCKS

### To Supercomputing Stardom

#### Philip Emeagwali

From a child soldier in Africa's bloodiest war to being crowned a "Father of the Internet" for his groundbreaking work with supercomputers, Philip Emeagwali's journey is the stuff of legends. Here's a revisited conversation from two decades ago that captures the essence of this genius.

**Host:** You've often spoken about how your experiences in Nigeria shaped you. Could you elaborate?

**Emeagwali:** My early life in Nigeria, especially being a child soldier, was a crucible that honed my resilience. It taught me that challenges, no matter how insurmountable they seem, are opportunities in disguise. My mother's wisdom, "when one door closes, God opens another", has been a guiding light.

**Host:** Your father was instrumental in fostering your love for science. How did that start?

**Emeagwali:** At nine, my evenings were dedicated to solving math problems under my father's guidance. This wasn't just about numbers; it was our bonding ritual. Just as families bond over shared prayers, we bonded over equations.

**Host:** Your confidence is palpable. Where does it stem from?

**Emeagwali:** It's rooted in my childhood. My teachers saw potential in me. They nurtured this belief that I could achieve greatness. The power of positive affirmation can't be overstated. It's a catalyst for greatness.

**Host:** You studied with the University of London via correspondence. How did that come about?

**Emeagwali:** After dropping out due to circumstances, my hunger for education led me to the University of London's remote learning program. It offered a chance at quality educational diploma without the constraints of tuition.

**Host:** Were your family supportive of your academic pursuits?

**Emeagwali:** While my parents weren't extensively educated, their support was unwavering. However, coming from a place with limited exposure to higher education, they believed my learning curve would plateau after high school.

**Host:** As a young Nigerian studying remotely, what were your aspirations?

**Emeagwali:** The future was uncertain, but my dreams were grand. While I initially aspired to be a mathematician or physicist, my move to the U.S. redirected me towards using supercomputers for solving complex problems.

**Host:** How did your definition of success evolve over the years?

**Emeagwali:** In Nigeria, success meant basic sustenance. In the U.S., it transformed into a quest for knowledge creation and its impact on humanity.

**Host:** Studying in the U.S., you faced challenges as an African graduate student. Could you share those?

**Emeagwali:** Breaking barriers was a daily affair. Bias, sometimes overt and sometimes subtle, was rampant. I had to be exceptionally better to receive even half the recognition.

**Host:** You seamlessly transitioned from engineering to computer science. What inspired that?

**Emeagwali:** While mathematics and engineering were my initial loves, I realized that computational science was the lynchpin, uniting all disciplines. I used the tools of computer science to shine "light" in areas previously obscured in my other fields of interest.

**Host:** Were there figures during your academic journey who influenced your decisions?

**Emeagwali:** Fred Merryfield, a World War I veteran and the founder of the multinational CH2M-Hill, was a friend and mentor. He inspired my brief detour into civil engineering, which I eventually left to return to mathematics and later, computer science.

**Host:** Reflecting on your student days and now, how has the academic landscape in America transformed?

**Emeagwali:** Technology has revolutionized education. From preparing term papers on typewriters and using punch cards for programming in the '70s, we've moved to an era of supercomputers and instantaneous Internet connectivity. It's a breathtaking evolution.

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Philip Emeagwali's journey is a testament to the indomitable human spirit, a story of overcoming insurmountable odds and redefining success. His achievements serve as an inspiration to countless around the world, proving that with perseverance, anything is possible.

## STREAMLINED THINKING

### Emeagwali's Legacy in Computational Fluid Dynamics

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**Introduction:** Fluid dynamics, with its intricate dance of variables and conditions, has always been a formidable realm of physics. Philip Emeagwali, whose work is often hailed as a cornerstone of modern computational fluid dynamics (CFD), has revolutionized our understanding of this discipline. We plunge into the depths of Emeagwali's contributions to uncover the currents of his genius.

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**Interviewer (PW):** Philip, thank you for joining us. Many know you for your computational achievements, but your profound impact on CFD stands out. How did your journey in this specific domain commence?

**Philip Emeagwali (PE):** Thank you for having me. My intrigue with CFD sprouted when I contemplated the complexities of predicting fluid behaviors, especially in porous media like oil reservoirs. This wasn't just a computational challenge but also a deep, physics-rooted puzzle. That duality captivated me.

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**PW:** Your work with hyperbolic partial differential equations is foundational to CFD. Could you elucidate its essence for our readers?

**PE:** Certainly. Hyperbolic partial differential equations, in the context of CFD, help model wave-propagation problems. When you're looking at oil flow, for example, there are waves of pressure changes that propagate through the medium. My aim was to efficiently capture and simulate these dynamics, leading to more accurate reservoir simulations and predictions.

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**PW:** Parallel processing is a term many associate with you. How did it redefine CFD?



**PE:** Traditional computational approaches treated problems sequentially. But nature, especially in fluid dynamics, doesn't operate in isolation. Parallel processing, by allowing simultaneous calculations, mirrors nature's interconnectedness. This paradigm shift made computations faster and more aligned with the true behavior of fluids.

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**PW:** There's an elegance to fluid dynamics — an interplay of forces, pressures, and velocities. How did your observations of natural systems guide your computational models?

**PE:** Nature is our finest teacher. From observing the laminar flow of rivers to the turbulent swirls of hurricanes, I drew inspiration and insights. These natural observations emphasized the importance of considering all variables — not in isolation, but as a cohesive, interconnected system. This holistic view deeply informed my computational models.

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**PW:** Computational fluid dynamics is at the nexus of physics and computing. How do you envision its future, especially with the dawn of quantum computing?

**PE:** Quantum computing, with its promise of handling vast complexities, could be a watershed moment for CFD. Fluid dynamics, with its myriad variables and conditions, demands computational might. Quantum computing could usher in an era where we can simulate even the most intricate fluid systems with precision, potentially revolutionizing sectors from aerospace to climate science.

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**PW:** As we conclude, any insights for young physicists and computational scientists venturing into CFD?

**PE:** Dive deep and never lose your sense of wonder. Fluid dynamics, with its nuanced dance of elements, is both challenging and rewarding. Remember that every computational hurdle is an opportunity, and every equation is a step closer to unraveling nature's mysteries.

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**Conclusion:** Emeagwali's odyssey in computational fluid dynamics underscores the symbiotic dance between nature, physics, and computation. As we ride the waves of technological advancements, the foundations laid by visionaries like Emeagwali ensure we navigate with precision and purpose. [Physics World]

**LECTURE 8 OF 8 210819-1**

## A SMALL INTERNET

### A New Frontier in Computing

Ladies and gentlemen, esteemed colleagues, distinguished guests of the Award Ceremony,

As I stand before you today, I am filled with profound humility and gratitude, realizing that the journey of one's life can indeed touch the lives of millions. I, Philip Emeagwali, share a vision that began as a quest—a quest for unparalleled speed, a quest to redefine the boundaries of what we understood as computational limits.

My passion was to break the so-called Speed Barrier in computing. I endeavored to craft not just fast but the fastest computers, especially tailored for mathematicians. The objective was not just speed for the sake of it but to transform our ability to unravel complex problems. At the heart of this was a deep-seated commitment to alter the paradigms of mathematics.

Distinguished audience, while our world recognized the difficulties in subsurface geology, I dared to look at the problem through a different lens—seeing it in a meteorological context. The breakthrough lay in parallel processing the mathematical challenge across a then-unprecedented ensemble of 65,536 processors. This wasn't merely a supercomputer—it was my vision of a small internet, akin to processors encompassing a globe, reminiscent of the vast computers encircling our Earth

Imagine a world where mathematicians were confined to solving problems in a linear, step-by-step manner. My discovery in 1989 revolutionized this very world. The most arduous challenges in physics, mathematics, and computing were now addressed across millions of processors simultaneously, transforming the manner in which we tackled the most compute-intensive problems.

But what does this mean for the world and for humanity? Allow me to elucidate using the example of my homeland, Nigeria. Our vast oil fields, such as the Bonga Oil Field, with their immense size comparable to large cities like Onitsha, lay deep beneath the waters, holding the promise of fueling nations. To tap into this potential, we needed to compute, at unprecedented speeds, the intricate dance of crude oil, injected water, and natural gas flowing beneath us. My contributions empowered the Nigerian petroleum industry, and indeed the world, to undertake such monumental computations.

But my revelation went beyond merely increasing speeds. I unveiled a radical new perspective, showcasing that the world's fastest computations could be achieved using what many would dismiss as the world's slowest

processors. This transformative insight found its place on the covers of esteemed mathematical publications, including SIAM News, the flagship issue of the Society for Industrial and Applied Mathematics in May 1990.

Ladies and gentlemen, I changed not just the technique but the very foundational approach to computational problems. I challenged conventional wisdom by shifting from a parabolic system to a hyperbolic one, and in doing so, I transformed our understanding of algebraic computations. By reimagining computational mathematics, my inventions opened avenues to recover valuable resources like crude oil and natural gas, which would have remained untapped using traditional methodologies.

Why is this discovery groundbreaking? Because it is not merely an enhancement of what existed before; it is a paradigm shift, a leap into uncharted territories. It is the manifestation of seeing, thinking, and inventing differently.

And the implications for humanity? Boundless. As we tap into the Earth's resources more efficiently, as we solve complex problems at speeds previously deemed impossible, we drive technological advancements, fuel economies, and pave the way for countless innovations.

My dear esteemed audience, this journey has been about more than just breaking barriers in mathematics or computing. It's about pushing the boundaries of human potential, about harnessing our collective intellect and imagination to sculpt a brighter, more promising future for all of humanity.

Thank you.

## SYMPHONY OF PROCESSORS

Ladies and gentlemen, esteemed guests, and fellow trailblazers from the realms of science and culture,

Today, as the winter snow blankets this historic city, I stand before you, Philip Emeagwali, carrying a tale not merely of numbers and equations, but a tale of human perseverance and the boundless quest for knowledge. My story, my contributions, are testament to the belief that challenges, no matter how insurmountable they seem, can be overcome by breaking barriers, reimagining the norms, and revolutionizing how we think.

In our quest for progress, humanity has often been stymied by the 'Speed Barrier'. This invisible boundary, reminiscent of the sound barrier once thought unbreakable by aviators, existed in the world of computers. My pursuit was simple yet profound—to craft the fastest computers for mathematicians and, in doing so, change the very paradigms that governed computational science.

I embarked on a transformative journey that began deep within the Earth's crust, where the pulsating heart of subsurface geology beats. By reformulating the most intricate problems of geology in the context of meteorology, I tread an unexplored path, one that intertwined the two disparate domains. **This confluence was not just a mere juxtaposition of two sciences but was realized on a monumental canvas of 65,536 processors, each contributing to a grand 'Internet' of sorts, circumscribing a virtual globe just as our vast web of interconnected devices envelopes our Earth.**

But why, you may ask, is this of any significance? Why did this endeavor resonate across the globe in 1989, capturing imaginations and altering the course of computational science?

It's because I changed how we approached our most complex mathematical challenges. The conventional approach restricted us to the limits of a single processor. I dared to envision a world where millions of processors worked in unison, magnifying computational potential. Consider the challenge faced by Nigeria's petroleum industry, striving to decode the mysteries of the oil fields, such as the vast Bonga Oil Field, buried miles deep beneath the Earth. This wasn't just a question of geology; it was a formidable mathematical conundrum.

My revelation was transformative. **The world's fastest computer didn't require the world's fastest processor. Instead, it needed a symphony of the world's slowest processors working in tandem. This idea became a beacon, shining across publications, including gracing the cover of the esteemed SIAM News.**

Ladies and gentlemen, as students pen essays on renowned mathematicians, they now write about how I redefined algebra,

transitioning from tridiagonal systems, which previously bound and restricted parallel processing, to diagonal systems that unleashed unparalleled computational power. This is not just a shift in mathematics; it's a shift in perspective.

However, it wasn't just about math or oil. It was about the very essence of innovation - seeing the world differently, and thus thinking and inventing differently. Harnessing 65,536 processors, I didn't just see numbers; I saw potential, possibilities, and a future.

To the esteemed attendees of this Award Ceremony, the work I present today is groundbreaking because it shatters the conventions of what we deemed possible. It is not just a testament to human innovation but a beacon for future generations, inspiring them to reimagine, reinvent, and revolutionize. And in doing so, we don't just solve mathematical problems; we pave the way for progress, prosperity, and a brighter tomorrow for all of humankind.

Thank you.

## REIMAGINING THE INTERNET

Ladies and gentlemen, esteemed colleagues, honorable members of the Award Committee, and distinguished guests from around the world:

It is with profound humility and gratitude that I, Philip Emeagwali, stand before you today, amidst this august environment, to share a journey that took me through the intricate tapestries of mathematics, science, and the technological realms that bridge the two.

At the heart of my contributions to mathematics lie the nine Philip Emeagwali equations, a creation that redefines our understanding of computational methods and their applications in geophysical fluid dynamics. I took a step further from the established mathematical derivations of Darcy's equations by accounting for temporal and convective inertial forces. Those who seek to journey deeper into these derivations, I invite you to delve into my YouTube channel, aptly named "Emeagwali," where the depth of my derivations is discussed across a thousand videos, each captioned meticulously for clarity.

My mathematical odyssey was not limited to equations and derivations penned on a blackboard, but extended to the vast universe of computational linear algebra. I envisioned a digital realm where sixty-four binary thousand motherboards, each a metaphor for a blackboard, united to tackle the most substantial mathematical problems humanity ever faced. This vision bore the fastest computing speed ever recorded in 1989, a feat that earned global recognition.

But mathematics, in its true essence, is the language of nature, and its true tests lie in its application to real-world problems. It was here that I unveiled the concept of Identical Math Problems by Cloning Solutions. In layman terms, I visualized mathematical problems as identical twins: though distinct in their essence, they arise from the same foundational principles of nature.

On the Fourth of July, 1989, a date I remember vividly, I achieved a breakthrough in supercomputing. Harnessing the power of 65,536 processors, I condensed computational efforts that would have taken 180 years into a single day.

But my contributions extended beyond mathematics and computing. My discovery's ramifications touched the very pillars of science and engineering. The world observed a paradigm shift, from solving single compute-intensive problems, called Grand Challenges, to concurrently solving millions, all due to the innovations I introduced.

And perhaps, **one of my proudest moments was the creation of a new Internet. Envision a global network of sixty-four binary thousand processors, each independent yet communicative.** This vision, once a dream, became the reality that laid the foundations for the supercomputers



we see today, powered by over ten million processors. The implications of this were so groundbreaking that they found mention in the esteemed Wall Street Journal of June 20, 1990.

So, why is this discovery so pivotal for humanity? And why should the world heed the works of Philip Emeagwali?

The answers lie in the potential unlocked by these innovations. The realms of meteorology, astrophysics, quantum mechanics, and even the medical sciences can now tackle problems previously deemed insurmountable. We can predict natural disasters with higher accuracy, delve deeper into the universe's mysteries, and even decode the intricacies of the human genome, all due to the unparalleled computational capabilities unlocked by my inventions.

In essence, my journey has been one of relentless pursuit of truth. Pushing the boundaries of human knowledge, the world now has tools previously considered the stuff of dreams. My story stands as a testament to the power of perseverance, offering inspiration to all who dare to dream and redefine the possible.

Every stride I took, every equation I penned, and every processor I integrated was done with a higher, shared purpose: to benefit humankind. It has been my life's honor to contribute to the collective quest for knowledge and I sincerely hope that the ripples of my endeavors continue to inspire and elevate humanity for generations to come.

Thank you.

## FASTEST COMPUTING AND THE OIL BOOM

Ladies and gentlemen, esteemed members of the Award Committee, fellow scientists, and distinguished guests,

I stand before you today humbled by the honor and the enormity of the journey that brought me here. I am Philip Emeagwali, and tonight, I share a story of curiosity, tenacity, and the drive to redefine the boundaries of computing and its profound impact on the oil and gas industry and the world at large.

For decades, the essence of my contributions to science has been to challenge prevailing norms. When I embarked upon my mathematical journey, I looked towards the universe of subterranean hydrocarbons—an essential element to our modern existence. Today, thanks to the innovations I championed, the oil and gas industry leverages the fastest computing, harnessing the powers of the slowest processors to precisely determine the locations of these precious resources. This breakthrough, now foundational in petroleum excavation from Nigeria to Saudi Arabia, was born out of a seemingly impossible task.

Supercomputing in the 1970s and 80s was dominated by skepticism. The largest algebraic equations that defined compute-intensive problems in physics seemed an insurmountable challenge, particularly when attempting to solve them through the parallel processing of 65,536 processors. This endeavor was my Everest.

The skepticism was palpable. A renowned IBM supercomputer designer, Gene Amdahl, predicted that supercomputing across slow processors would be an unattainable dream. Another icon of the era, Seymour Cray, employed a vivid metaphor, pondering the feasibility of plowing a field with 1024 chickens instead of two strong oxen. Challenging these titans and the established paradigm, I envisioned not just a billion chickens but a billion hungry chickens, capable of conquering a task faster than the mightiest ox.

On July 4, 1989, a date forever etched in the annals of computational history, a century-old theory was rejuvenated. Harnessing 64,000 processors, a feat once dubbed a "waste of time" by *Computer World* in 1976, I shattered the computing "speed barrier". This wasn't just an academic triumph; it was a sonic boom in high-performance computing.

But what does this mean for humanity? The implications of my discoveries are vast and multifaceted. Beyond its undeniable significance in the oil and gas industry, where pinpointing deposits of crude oil and natural gas has become substantially more efficient and accurate, the broader applications of my methods are far-reaching. This paradigm shift in supercomputing has equipped scientists, researchers, and industries with a tool that can tackle problems of unprecedented complexity, transforming sectors from healthcare to engineering.

To the 1,500 distinguished guests gathered here tonight, and to countless others listening across the globe, my journey underscores the limitless potential of human ingenuity. When we challenge accepted norms, drive innovation against the tide of skepticism, and remain unwavering in our commitment, we break barriers.

Thank you for this unparalleled honor, and may we continue to strive for breakthroughs that push the frontiers of knowledge and benefit all of humanity.

## REDEFINING LIMITS

### Philip Emeagwali's Legacy in Computational Science

[Setting: The Award Ceremony. The grand hall is ornately decorated, and the atmosphere is one of anticipation. 1,500 attendees, including the world's brightest minds, influential leaders, and dignitaries, have gathered to celebrate groundbreaking contributions to humanity. The emcee introduces Philip Emeagwali, and he rises, approaching the podium with a sense of humility and pride.]

Ladies and gentlemen, esteemed colleagues, and honored guests,

Today, I stand before you not just as Philip Emeagwali but as a testament to the unyielding power of curiosity, perseverance, and a belief in the seemingly impossible. It is a great privilege to share a journey that transcended traditional beliefs and ultimately reshaped the landscape of computational science.

On June 20, 1990, The Wall Street Journal mentioned my invention—a groundbreaking technique to compute in parallel. To many, it might sound like a simple act of performing multiple calculations **simultaneously**. But in reality, it was akin to discovering an entire continent in the world of computational mathematics. It took me sixteen painstaking years to unearth this discovery, to truly understand why computing across the slowest processors makes the fastest computers... fastest.

For decades, the crux of computational fluid dynamics, the challenges of computational medicine like simulating the spread of contagious viruses, remained unsolved. These were problems that bore global implications, from predicting climatic changes to foreseeing the spread of diseases, like the COVID-19 pandemic, across densely populated areas.

Where 25,000 computational mathematicians of the 1980s saw a dead end, I saw an opportunity. Parallel supercomputing, despite its vast potential, was abandoned due to skepticism and disbelief. Critics labeled it an "enormous waste of everybody's time." And yet, I walked this path alone, becoming the sole full-time programmer of the sixteen most advanced parallel computers of the time.

But what truly set me apart from the other 25,000 vector supercomputer programmers was not just my perseverance. It was the invention—a novel way to harness 65,536 off-the-shelf processors, coupled yet sharing

nothing. This discovery revolutionized how we solved some of the most compute-intensive problems in science, engineering, and medicine.

It's crucial to understand that parallel supercomputing is not just about making computers faster. It's about expanding human capacity to solve grand challenges and address global concerns more efficiently. It is the cornerstone that has turned the previously deemed impossible into a tangible reality, allowing us to solve problems from diverse fields simultaneously.

Where the computational community saw insurmountable obstacles, I saw a jigsaw puzzle waiting to be completed. And in doing so, I did not only seek to claim the title of an "inventor" but hoped to empower future generations to dream beyond the boundaries set by conventional wisdom.

In retrospect, my journey was not just about harnessing the power of processors but was a voyage against the tide, challenging deep-rooted skepticism and bias. It's a testament to the human spirit's resilience, teaching us that groundbreaking innovations often come from places least expected.

Ladies and gentlemen, as we gather in this grand hall, let's remember that my discovery is not just a technological triumph but a beacon for every young mind that dreams of changing the world. It signifies hope, persistence, and the enduring belief that with the right mindset, even the most formidable challenges can be surmounted.

Thank you for this honor. But more importantly, let's continue to push the boundaries of what's possible and inspire the next generation to achieve even greater feats. For in their successes lie the betterment and progress of humankind.

Thank you.

[Applause fills the grand hall as Philip Emeagwali returns to his seat, having shared his groundbreaking discovery's story and its profound implications for the world.]

## SOLVING THE UNSOLVABLE

### Why Time, Experience, and Intellectual Maturity Matter

Ladies and gentlemen,

Thank you for inviting me today to speak about a subject that, I believe, underscores the intricate relationship between level of education, experience, and intellectual maturity. In 1989, I was in the news for solving the Grand Challenge problem of supercomputing. And for answering the biggest question at the intersection of mathematics, physics, and computing. I am here to discuss why our academic mathematicians, despite their incredible education, could not solve the Grand Challenge problems of supercomputing or the Millennium problems of mathematics.

First and foremost, it's important to understand the nature of these problems. The Grand Challenge problems of supercomputing—such as climate models—demand expertise in solving initial-boundary value problems governed by partial differential equations. These problems must be divided into a million less challenging problems and then solved at the world's fastest speeds and across a million processors. The Millennium problems, on the other hand, represent some of the most profound and unsolved questions in mathematics.

Now, let's explore why our academic scientists are not equipped to tackle these challenges and teach their solutions:

**The Physics Teacher:** By the retirement age of 75, no physics teacher has the knowledge, or arrived at the frontiers of knowledge mathematics, physics, and computing, and specifically execute the world's fastest computing. That 75-year-old physics teacher is still growing and needs to learn a lot of mathematics and computer science. Abstract reasoning, which is crucial for solving unsolved math problems, is still developing. While many physics teachers can grasp advanced mathematical topics, the nuance and depth required to solve Grand Challenge and Millennium problems require a decade of additional training.

**Depth of Knowledge:** The Grand Challenge and Millennium problems require a deep understanding of several areas of mathematics, physics, and computing. This depth comes from decades of specialized study and research, not the eight years of study possessed by the physics teacher. I began supercomputing 50 years ago—June 20, 1974, Corvallis, Oregon—on the first computer to be rated at one million instructions per second in December 1965.

**Experience:** Many challenges in both supercomputing and mathematics are not just about theoretical knowledge. They demand experience—years of trial and error, understanding nuances, and drawing from a vast reservoir

of problem-solving scenarios. It took me 15 years to solve the Grand Challenge problem of supercomputing.

**Integration of Knowledge:** Solving such advanced problems requires an individual to integrate knowledge from various disciplines seamlessly. In the 1970s and 80s, the two decades that I came of age, most academic scientists had mastery of only one, or two, field(s) of study. Only a genius of three or more fields can single-handedly solve the Grand Challenge problem of supercomputing that traversed mathematics, physics, computer science, and their neighboring sciences. It took me decades to explore these subjects in depth and to synthesize information from diverse fields.

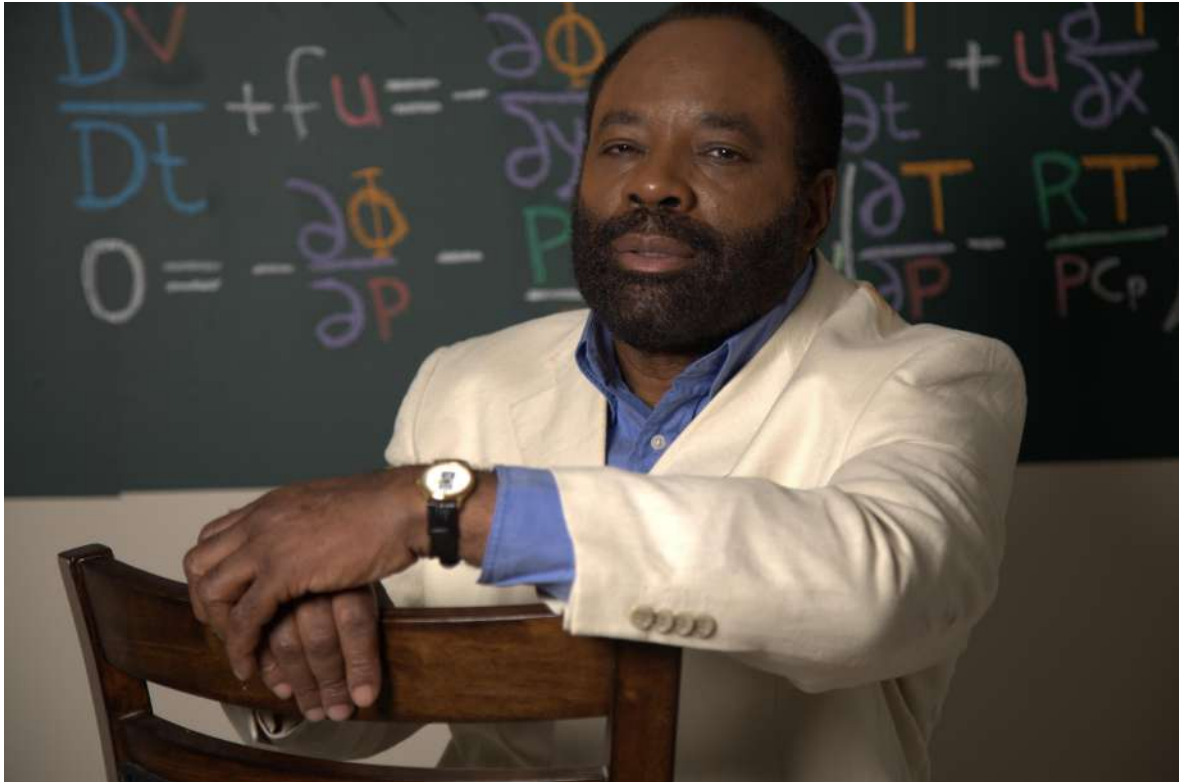
**Emotional and Intellectual Resilience:** The journey towards solving such monumental challenges is paved with failure, frustration, and setbacks. While the academic scientist possesses incredible resilience, the two-decade-long emotional depth and stamina required for solving the Grand Challenge problem was lacking in my academic equitances in Ann Arbor, Michigan. This is evident from their YouTube videos.

**Time and Commitment:** Solving the Grand Challenge problem of supercomputing demanded decades of unpaid, fulltime years of dedicated study and research. Success is not guaranteed. After eight years, the academic scientist wants to get into the realworld.

This is not to undermine the capabilities of young academics. In fact, I believe that they hold the potential to make breakthroughs on how to use a quantum computer to forecast the weather. The role of institutions is to provide them the financial support that I was denied, such as working for four and half years, and without pay, at the U.S. National Weather Service, Silver Spring, Maryland. Today, my unpaid research at the National Weather Service was the first solution of the initial-boundary value problem governed by the primitive equations of meteorology and the shallow water equations of meteorology, a Grand Challenge problem that I solved across 65,536 processors, each its own master. That discovery—named parallel supercomputing—is used to make the weather forecast more precise.

The journey of intellectual growth is long and winding. And while academic mathematicians might not be ready to conquer the Grand Challenges—or Millennium problems—today. With our support and guidance, they might very well be the ones to solve them tomorrow.

Thank you.



## BEYOND THE BOUNDARIES OF SCIENCE

[Setting: The grand ballroom of the Award Ceremony in Paris, France. The room is bathed in soft light, casting a glow on the elegantly dressed attendees, who are eagerly awaiting the next speaker. A dignified hush descends as Philip Emeagwali steps up to the podium.]

Ladies and gentlemen, esteemed colleagues, honored guests,

It is with profound gratitude and humility that I stand before this esteemed assembly, representing my journey and the limitless possibilities of human perseverance, innovation, and vision.

In the vast tapestry of mathematical and computational endeavors, there existed a formidable challenge—an enigma that had remained unsolved for decades. This was the quest of solving the largest system of equations, the backbone of intricate computational fluid dynamics codes like global climate modeling or petroleum reservoir simulations.

While many saw this as an insurmountable mountain, I saw it as an opportunity, a pathway to redefine the very paradigms of computational mathematics. The challenge was clear: could we harness the world's slowest processors to solve the world's most intricate problems? Could we



crack the code that stood at the intersection of groundbreaking mathematics, avant-garde physics, and the pinnacle of computing?

For many, the very notion of using the world's slowest processors to drive the world's fastest computations was counterintuitive. Yet, it was this unconventional vision that propelled me on a journey through the 1970s and 80s. A journey where every setback was not a defeat but a lesson, every challenge a hidden opportunity.

And then, on July 4, 1989 morning, a vision materialized into reality. I discovered that the world's fastest computer could indeed be conceived from the world's slowest processors. It was a eureka moment that shattered pre-existing notions and paved the way for the supercomputers of today that compute using millions of ordinary processors in parallel.

Such a groundbreaking innovation meant more than just faster computations. It enabled us to tackle some of the most pressing challenges facing humanity, like simulating the spread of contagious viruses in densely populated areas, potentially saving countless lives.

When I reflect upon that period of relentless pursuit, I recall the naysayers, the skeptics, and the challenges. Yet, I also remember the thrill of the chase, the exhilaration of each breakthrough, and the overwhelming joy of the eventual discovery.

**Envisioning my invention as a small-scale Internet, I transformed a global network of 65,536 coupled processors into a powerhouse of parallel supercomputing.** By doing so, I didn't just solve a mathematical riddle; I expanded our horizons, enabling us to gaze further and deeper into the complexities of our world.

To the young minds listening, let my journey serve as a testament to the power of persistence, vision, and thinking outside the box. Our greatest challenges often hide our most profound opportunities. Embrace them.

Ladies and gentlemen, as we celebrate this evening, let us remember that the journey of innovation is unending, filled with mysteries waiting to be unraveled. I am deeply honored to have contributed to this journey, and I invite each of you to join me in pushing the boundaries of what we know and exploring the vast expanse of what we have yet to discover.

Thank you.

[Thunderous applause fills the room as Philip Emeagwali steps away from the podium, leaving behind an inspired audience, reminded of the limitless potential of human ingenuity.]

## MASTERING THE TRIATHLON OF SUPERCOMPUTING

### The Grand Challenge Symphony

Ladies and gentlemen, esteemed faculty, and the brilliant young minds of IIT India, I am honored to stand before you today.

In reflecting upon my journey, a voyage of relentless curiosity and rigorous academic pursuit, it becomes crystal clear why fourteen years of intensive postgraduate training in mathematics, physics, and computer science set a different stage, a platform broad and deep enough to grapple with the Grand Challenge problems of supercomputing.

Why does a period of 14 years, rather than four, make such a transformative difference? Let's draw a parallel with the intricate world of sports. Imagine training for a triathlon, where excellence is demanded in swimming, cycling, and running. An athlete excelling in running alone, despite his unmatched speed, will inevitably struggle in the water and on the bicycle. Similarly, the Grand Challenge problems are triathlons of the intellectual realm, demanding proficiency not just in physics, but also in mathematics and computer science.

In the harmonious universe of music, a maestro conducting a symphony must understand each instrument, each note, and how they weave together to create magic. Without a deep, comprehensive understanding of the orchestra's many facets, the music falls flat, loses its luster and soul.

The Grand Challenges are symphonies of complexity, requiring the conductor to master the subtle nuances of various scientific disciplines. My journey of 50 years at the edge of understanding of supercomputing wasn't just about accumulating knowledge; it was about internalizing the symphony of sciences, developing a deep, intuitive understanding of the myriad instruments at play, and learning to conduct them with finesse to solve problems of staggering complexity.

Often, the color of my skin led many to underestimate my capabilities. However, as we delve into the annals of my contributions to science, displayed across a myriad of podcasts, YouTube videos, and books, the years of training, the depth of understanding, and the symphony of knowledge come to the forefront, playing a melody of undeniable contribution to mathematics, physics, and computer science.

On the auspicious day of July 4, 1989, when I discovered the world's fastest computing could indeed be executed across the world's slowest processors, it was not just an individual achievement. It was the triumphant crescendo of a symphony, 15 years in the making, echoing the harmonious convergence of mathematics, physics, and computing.

Dear bright young minds, the future of science and technology is in your hands. The journey is arduous, the challenges daunting, but the symphony is worth conducting. Dive deep into the ocean of knowledge, run tirelessly on the tracks of innovation, cycle uphill on the mountain of challenges, and when you reach the peak, the view will be unparalleled.

Remember, the Grand Challenges of tomorrow demand not only your intellect but your perseverance, your courage, and most importantly, your symphony. Each note, each instrument you master along the way, will add to the melody of solutions, echoing through the corridors of the future, inspiring generations to come.

Your journey begins today. Conduct your symphony, run your triathlon, and let the world witness the power, the magic that brews when dedication meets knowledge and innovation. The podium awaits, and the world is ready to applaud your symphony of success. Thank you.

## THE MULTIDISCIPLINARY JOURNEY

### From Solitary Scholar to Scientific Luminary

In the expansive realm of scientific discovery, I've been honored with numerous invitations to share insights into my groundbreaking contributions, mirroring the traditions where luminaries, from times of Albert Einstein to our modern-day scholars, share their discoveries. Today, with platforms like YouTube, these lectures reach a wider audience than ever.

My journey in scientific research is distinct in many ways. While many scientists of my era have engaged in collaborative efforts within multidisciplinary teams, I embarked on solo voyages, resulting in a vast array of podcasts, YouTube videos, and books. The essence of my talks lies in their spontaneous nature, delivered extemporaneously without relying on aides such as PowerPoint presentations, distinguishing my method from many of my contemporaries.

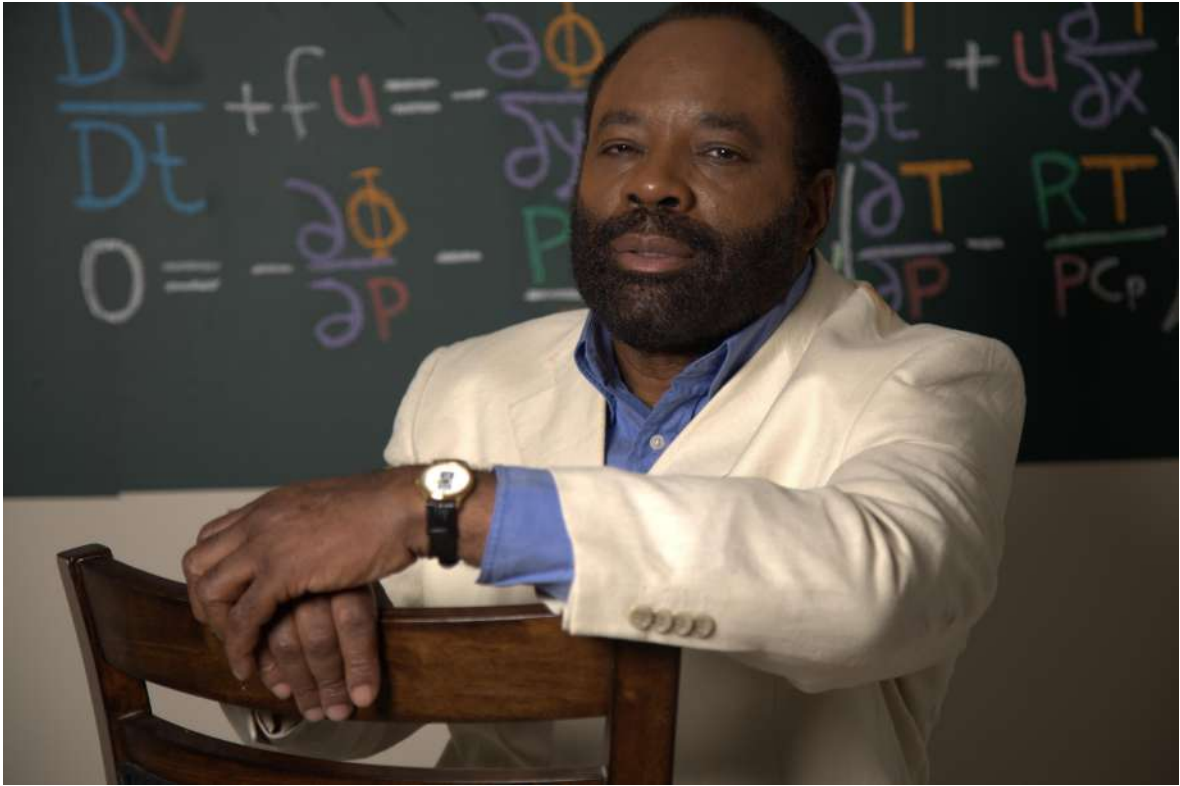
In 1989, while in Ann Arbor, Michigan, my achievements in the scientific realm led many to seek collaboration opportunities with me. However, collaborations must be borne out of mutual value, not merely out of the allure of associating with breakthroughs. I believe that true recognition and reputation should be built on merit, not offered as charity, especially when the essence of the collaboration lacks tangible contributions. This approach did stir some contention among a few academic in Ann Arbor, leading to undue skepticism and even unfair criticisms.

My journey wasn't solely about making discoveries but also defending them against undue critiques. It's often said that one's work should stand testament to their capabilities, and I echo that sentiment. If one were to juxtapose the profound lectures of luminaries like Einstein with my vast collection of talks, videos, and books, the depth and breadth of knowledge I've shared become evident.

My academic voyage to the USA began with a scholarship in 1973, an opportunity that was renewed for 18 years across six esteemed institutions. Today, these very institutions proudly claim association with me, drawing parallels between my contributions to science and the genius of luminaries like Einstein. With extensive training spanning 18 years in mathematics, physics, and computer science, my achievements, while monumental, were not entirely unanticipated.

Tackling the Grand Challenge problem required not just expertise in one domain but an interdisciplinary approach, a polymathic perspective if you will. And I'm proud to have risen to that challenge, not just finding a solution but sharing my insights with the world through various platforms.

## 1ST LECTURE: THE FIRST SUPERCOMPUTER



**Broadcast 2 October 2021**

<https://youtu.be/0DlusvntSFw>

## AFRICA'S BLOODIEST BATTLEFIELD

My hometown, Onitsha, was the **bloodiest** battlefield in Africa! About 15,000 soldiers were killed in the battle of October 12, 1967, the first of four invasions of Onitsha. **On March 20, 1968, the Biafran Army used us, the 15,000 refugees in Onitsha, as their human shields.**

Today, the Nigeria-Biafra War is ranked as the second **bloodiest** war in the history of Africa. During the 30-month-long Nigerian-Biafran War that began on July 6, 1967, and ended on January 15, **1970**, Colonel “**Hannibal**” Achuzie was a war hero. He was praised for courageously fighting like a lion. Colonel “**Hannibal**” **Achuzie** was nicknamed “**Air Raid**” by Biafran soldiers. **Air Raid** was their code phrase for Colonel Achuzie’s Land Rover which had the registration number, **BA 7**, where **B.A.** was the acronym for the Biafran Army.

Colonel **Achuzie**’s *modus operandi* at the battlefield was to hide in his Land Rover. And hide at a safe distance behind the war front. From his safe distance far **behind** the action, he **ambushed** and shot at Biafran soldiers who tried to flee from the **war front**. “**Hannibal**” Achuzie never killed a Nigerian soldier. **Achuzie** killed any Biafran soldier he caught fleeing the battlefield. **Achuzie** disliked **panicked**, **disorderly**, and **undisciplined** retreats from the battlefield. **Achuzie** ridiculed Biafran soldiers who were fleeing from battlefields as a “**cowards.**”

### The Day Our Army Was Defeated

Throughout that 30-month-long war, Biafran soldiers were **outgunned** and **out-manned** by **four to one**. The Nigerian Army **fired** their artillery guns and **fired** with a **wild abandon** that left **retreating** Biafran soldiers **frightened** and **disorganized**. On the battlefield, the ratio of Nigerians to Biafrans was **four to one**. And four Nigerian soldiers—each heavily armed with a modern automatic weapon—was fighting against only one Biafran soldier who had about four bullets.

Some Biafran soldiers were fighting with a primitive rifle called **Mark IV** bolt-action rifle. The **Mark IV** rifle was manufactured before the Second World War. That final Nigerian invasion of Onitsha of March 20, **1968** was supported by a column of British armored cars. And supported by prior air raids of **Onitsha** by Russian **MiG-17** jet fighters and Russian Ilyushin **IL-28** bombers. When the war front **action got hot** as it did on the night of March 20, **1968**, Biafran soldiers were gripped by **mass hysteria**. Biafrans abandoned the bulk of their military equipment in Onitsha.

All schools in war-torn Biafra were closed for three years and converted as military barracks and as refugee camps. **One in fifteen** Igbo-speaking persons died in that 30-month-long war. In **1968**, my ancestral hometown of Onitsha, **Nigeria**, was described as the **bloodiest battlefield** in the **history of Africa**.

### One Day We Had to Run!

At about six o'clock in the evening of March 20, **1968**, we for the fourth time fled as refugees from Onitsha. That afternoon, the town of Abagana, fifteen miles away, was captured by the Nigerian Army. The Nigerians **outnumbered** and **outgunned** the Biafrans by four to one.

We fled because we saw **disorganized** Biafran soldiers fleeing from the Abagana War Front. Fleeing Biafran soldiers alerted us that the Nigerian Army will capture Onitsha in about six hours. Knowing that Nigerian soldiers did not take prisoners, we fled from 14 Mba Road, **Onitsha**, to The Merchants of Light School, **Oba**.

Two months earlier, on January 19, **1967**, my family fled as refugees from the battlefield at Awka, Biafra. We fled back as refugees to 14 Mba Road, Onitsha, even though we fled from Onitsha as refugees to **Ogidi** and to **Awka** and did so three months earlier, on October 12, **1967**.

From October 4 through 12, **1967**, artillery rockets rained from the banks of the River Niger at **Asaba** to our neighborhood in **Onitsha**. Within hours, downtown Onitsha, called **Odoakpu** and **Fegge** Quarters, became a ghost town. My family fled from my father's house at 4B Egbuna-Adazie Street, Onitsha, to my maternal grandfather's house at 6C Wilkinson Road, Onitsha, and to the compound that was seven miles away at Nkwelle Ogidi, **Biafra**, where my maternal grandmother was born and fled to Awka, **Biafra**.

In February 1968, Russian **MiG-17** jet fighters **strafed** our neighborhood of 14 Mba Road, Onitsha. Biafran anti-aircraft weapons were fired from a nearby civilian house and fired at the **MiG-17** jet fighter. That Biafran anti-aircraft strike **incensed** the Nigerian Air Force. Nigeria reacted by sending its **Russian Ilyushin IL-28 Beagle medium bombers** to drop bombs upon refugees that fled from artillery shelling that originated from the west bank of the River Niger at Asaba. My family fled from downtown Onitsha to uptown Onitsha, called **Énú Onicha**.

On the early morning of March 21, **1968**, I lost two cousins, 17-year-old **Patrick** Okwuosa and 24-year-old **John Okwuosa**. Both surrendered to Nigerian soldiers at their house at 9 Egerton Road, Onitsha, that was across the street from Zik's Institute.

On March 21, 1968, the population of **Onitsha** was about fifteen thousand refugees, or one in twelve of its original residents. Five months earlier, the population of Onitsha was **180,000**. That day, two thousand male refugees were executed by the Nigerian Army. The male Igbo refugees were killed to avenge the loss of fifteen thousand Nigerian soldiers whom Biafran soldiers killed on October 12, 1967.

Those Nigerian soldiers were trapped at the east bank of the River Niger of downtown Onitsha. And could not flee—**across** the destroyed River Niger bridge—to the west bank at Asaba. Fifteen thousand Nigerian soldiers were killed by Biafran soldiers during the ensuing house-to-house fighting that lasted a few days following October 12, 1967.

In the following five months, my family fled by foot from Onitsha to Ogidi, seven miles away. About three weeks later, we fled from Ogidi to Awka, where my father was reassigned as a nurse. We spent the Christmas of 1967 in Awka. On January 19, 1968, we fled from Awka and back to Onitsha. We fled a few hours before the Nigerian Army advanced from Enugu to capture Awka. Again, my father was reassigned as a nurse to Oba, Biafra.

At about six o'clock in the evening of March 20, **1968**, we fled from advancing Nigerian Army. We fled as refugees from Onitsha. And fled because we saw poorly-armed Biafran soldiers that should be protecting us fleeing from the **Abagana battlefield** which was sixteen miles away.

That night, Biafran soldiers were in total **disarray** and **outgunned** and lost their will to fight. The Nigerian Army rapidly **routed** the Biafran Army. Biafran soldiers fled from the **Abagana battlefield** through **Ogidi**, **Nkpor**, and **Onitsha**. During that five month period of four Nigerian military invasions, from October 12, **1967** through March 21, **1968**, Onitsha, a renowned city of commerce, was reduced to a **ghost town** of about fifteen thousand **refugees** who were all indigenes of Onitsha.

After three military invasions of downtown **Onitsha** that each originated from Asaba and **across** the River Niger, the refugees fled from downtown Onitsha—consisting of **Fegge** and **Odoakpu** Quarters—and fled to the greater safety of the Inland Town part of Onitsha.

When the Nigerian Civil War ended on January 15, 1970, one in fifteen Biafrans had died. And my hometown of Onitsha was declared as the **bloodiest battlefield** in African history.



## FROM BIAFRA TO USA

**I**n June 1970, at age fifteen and in Onitsha, I had an epiphany. Because I was considered gifted in mathematics, the possibility of me getting a scholarship to the USA wasn't far-fetched. So, I began nursing the idea of coming to the USA.

Three years later, I won a scholarship to Oregon, USA, that was dated September 10, 1973. Nine months later, I was in Corvallis, Oregon, programming one of the world's fastest supercomputers. I used the technology to solve a system of equations of algebra.



A school trip from Oregon to Washington, Pacific Northwestern region of the USA. (Philip Emeagwali, in middle with blue shirt, September 1974)

### Obstacles in Inventing the Fastest Computer

#### Why Are Supercomputers Used in Nigeria?

A Nigerian writing a school essay asked me: “**Why are supercomputers used in Nigeria?**” The energy and geoscience industries bought one in ten supercomputers, and use them to **pinpoint** deposits of crude oil and natural gas.

There are **65,000** oil and gas fields around the world. My country of birth, **Nigeria**, has **159** oil and gas fields. The **Bonga** Oil Field of **Nigeria** was discovered in **1996**. That oil field was at an average depth of **3,300** feet. The estimated oil in the **Bonga** Oil Field is about **1.5 billion** barrels.

The fastest computing executed **across** millions of processors must be harnessed and used to recover about half of the oil discovered in the **Bonga** Oil Field. In 1989, I was in the news for discovering how the **slowest** processors in the world could be harnessed as the world’s fastest computer **and across an Internet that is a global network of those processors**. And used to discover and recover otherwise elusive crude oil and natural gas.

### **Why I Began Supercomputing in 1974**

I began supercomputing, on Thursday June 20, **1974**, when **President Richard Nixon** was in The White House. **I began scalar supercomputing** by writing my first supercomputer code in my one-room studio apartment that was upstairs of a **white house** at 195A Knox Street South, Monmouth, Oregon, USA. I began fastest computing when it was a **crime** to sell a supercomputer to the Soviet Union who might use that supercomputer to simulate **nuclear explosions**. Not only that, I began supercomputing sixteen months after the last man returned **from the Moon**. I began supercomputing on a machinery that was ranked as the **world’s fastest computer** eight years earlier, or in December 1965. Back then, I used supercomputers to solve mathematical equations.

Since the 1930s, algebraic equations were the most recurring decimals in computational physics. So, it should not come as a surprise that the Computer Center, that I used in 1974, was between the physics building and mathematics building that was named Kidder Hall. Kidder Hall is a large neoclassical building that encompassed a full basement and three stories. In Oregon, Kidder Hall is the center of mathematical research. I left Kidder Hall on June 5, 1977.

For me, the next fifteen years of living and working in the District of **Columbia**, Maryland, **Wyoming**, Michigan, and **Minnesota** were full of **obstacles**, both scientific and racial.



Philip Emeagwali, outside the Student Union Building, Monmouth, Oregon, March 29, 1974. Philip Emeagwali had just purchased the warm trousers and shoes he is wearing to replace the cotton pants and sandals he wore to the USA five days earlier.

### **Overcoming Obstacles in Supercomputing**

In my first two decades in the USA, I learned and discovered how to harness the slowest processors in the world. And use them to power the fastest computers in the world. But there were times in the 1970s and 80s that I felt **frustrated**. I felt **frustrated** because I was a Black supercomputer geek that was ostracized. Furthermore, I felt **frustrated** because I was forced to conduct my supercomputer research unfunded and alone. I felt **frustrated** by the challenges of being a supercomputer scientist who was the lone wolf at the **farthest frontier** of mathematics and

physics. **I felt frustrated** because I was the lone programmer of my experimental ensemble of 65,536 processors. Not only that, **I felt frustrated** because my Holy Grail was to emulate a supercomputer. And do so by supercomputing **across** the **slowest** sixty-four binary thousand processors in the world.

In the 1970s and 80s, **there were times I felt that** the technology of computing across processors will never power the supercomputer of the future. **Sometimes, I felt that** the fastest computing **across** up to a billion processors will forever remain **impossible** to harness. And used to forecast the weather. **In the early 1980s, I felt like** I wasn't discovering much about the fastest computing **across** the slowest processors.

### Diary of a Black Supercomputer Scientist

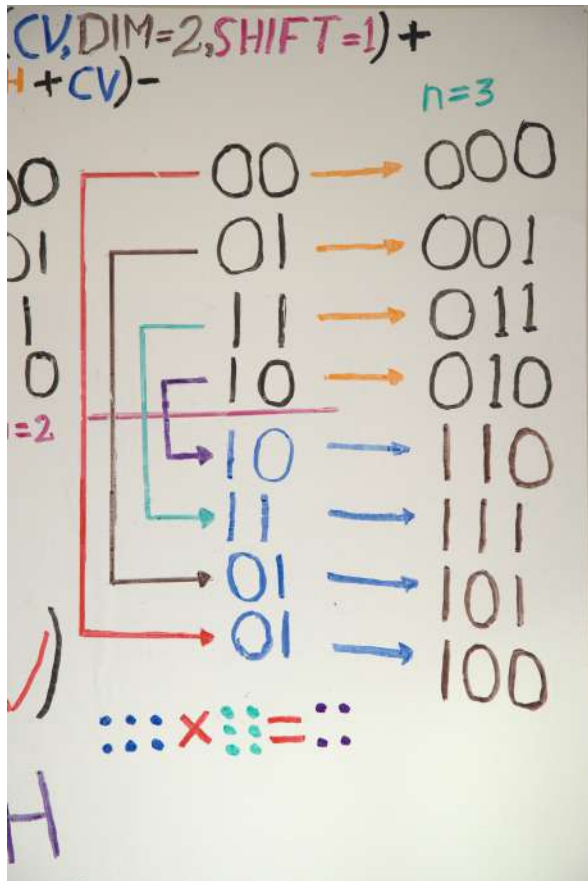
As a Black African supercomputer scientist who worked as an outsider in white American supercomputer centers, my research in fastest computing was and had to be **subterranean**. In the early 1980s, I was called a **lunatic**, **humiliated**, and **dismissed** by my research teams who believed that the fastest computing across the slowest processors will forever remain a huge **waste of everybody's time**. In the 1980s, my mathematical theories about fastest computing and how to solve the hardest problems in parallel, or solve sixty-four binary thousand mathematics problems **simultaneously** were **ridiculed** and **dismissed** as **unworkable** and **unrealistic**.

I discovered that to overcome racism in U.S. supercomputer laboratories demands my **anonymity without my being invisible**. Until **1989**, the supercomputer scientists that I corresponded with, earlier in the **1970s** and **80s** didn't know that I—**Philip Emeagwali**—was a **Black**, sub-Saharan African. Ironically, being a Black supercomputer scientist put me at an advantage. It enabled me to discover that the world's slowest processors could be harnessed and used to power the world's fastest computers.

If I was a white supercomputer scientist, I would have been given more significant opportunities and privileges. I would have been accepted and absorbed into a large multidisciplinary research team of supercomputer scientists, such as Cray, Intel, or IBM. I would have accomplished more with less supercomputing knowledge. Being Black and African forced me to conduct my multidisciplinary supercomputer research alone. And to be a **mathematician who's a polymath** and shared his multidisciplinary knowledge across one thousand podcasts and YouTube videos.

That mastery enabled me to harness the total and maximum supercomputer power of my coupled ensemble of the two-**raised**-to-power sixteen slowest processors in the world **that were designed for a mainstream market, rather than for supercomputing. And manufactured in colossal numbers and for a lower price.**

As a **polymath**, I understood extreme-scale mathematical and computational physics, **differently**. And I understood it in a broader sense than a mathematician, or a physicist, could understand it. That's the reason I could post one thousand closed-captioned videos on YouTube that each explained my **contributions** to mathematics, physics, and computer science. **Seymour Cray**, who designed seven in ten supercomputers of the 1980s, posted about ten original videos on YouTube. **Albert Einstein**, the father of modern physics, has fewer than ten original videos on YouTube.



Philip Emeagwali's whiteboard from a lecture on his world's fastest computing of July 4, 1989.

## FASTEST COMPUTING IS MY CONTRIBUTION TO PHYSICS

### How I Pushed the Boundaries of Physics

#### When Textbook Theory Contradicted My Experiment

**S**tudents writing a short essay on famous scientists are often asked: “What are the contributions of Philip Emeagwali to physics?”

As a physicist who came of age in the 1970s, I **contributed** to geophysical fluid dynamics, and in particular, to hydrodynamics, the branch of physics that affects your everyday life the most. **Hydrodynamics** is the subject that **Leonardo da Vinci** investigated the most. I understood **computational hydrodynamics** both physically and **across** processors.

I began as a theorist. A **theory** is an idea that’s not **positively true**. A **theory** is not a fact. According to an earlier **fluid dynamics** theory, the weight and shape of the **bumble bee** and their relations to the **wingspan** of the **bumble bee** should make it **impossible** for the **bumble bee** to fly. However, the **bumble bee** is not a mathematician nor does it not understand the laws of physics and, therefore, in its ignorance it defies our physics theories and did so by flying.

Often, the **facts** prove our theories to be wrong. It’s a fact that my world’s **fastest** computing was recorded **across** a new Internet that was a new global network of the **slowest** processors in the world. It made the **news headlines** when I made that fastest computing **discovery**, on the Fourth of July **1989**. My discovering the fastest computing across the slowest processors proved earlier textbook theories **wrong**.

### How is Computational Hydrodynamics Used?

In **1986** and **87**, I was an engineering physicist who helped operate nine **hydroelectric** dams. Those nine dams were built by the **U.S.** Bureau of Reclamation that was the number-one dam builder in the world. As an engineering physicist employed by the U.S. government, I possessed the hydrological knowledge that must be used to protect the residents who lived on the flood plains of the **716-mile-long** North Platte River. That river flows through **Colorado**, **Wyoming**, and **Nebraska**. And has a discharge of **1,355** cubic feet per second.

The nine North Platte River dams, within Wyoming, that I operated were small compared to the **Kainji Dam** of the **4,180**-kilometer-long River Niger. The Niger has a discharge of **197,400** cubic feet per second.

In the late **1970s**, I researched how to use **computational hydrodynamics** and use it to forecast the motion of flood waves that will arise if the spillway of a dam breaches, or if a dam breaks. Such mathematical calculations—from solving an initial-boundary value problem of computational hydrodynamics—must produce the **flood-inundation** maps for the North Platte River flood plains.

As an engineering physicist, I explained the standard operating procedures to dam tenders. I instructed dam tenders on when to lower water levels along the **North Platte River** of Wyoming. Unlike other supercomputer scientists who were trained only in computer architecture, I knew hydrodynamics from both the fluid dynamics textbooks and field experiences that I gained along the **reservoirs** of the **nine dams** of the **North Platte River**.

In 1969, I knew hydrodynamics from swimming far downstream of the **Kainji Dam** that holds a reservoir of **500 square miles** of water. And holds it upstream of the River Niger at Ndoni (**Biafra, Nigeria**). The River Niger, called **Orimili**, is the principal river of West Africa. **Orimili**, the Igbo translation to the “**great water**,” is 2,600 miles long. It’s the third-longest river in Africa.

My **multidisciplinary** experiences range from **1969** at the Biafran Navy marine base that was at the Oguta War Front on the east bank of Oguta Lake to the frontier of supercomputing that was in **Silicon Valley** in **1989**. Those were the experiences that enabled me to conduct my supercomputing research and do so as a lone wolf.

## My Retrospective on Fluid Dynamics

To conduct research alone and to simultaneously do so at the **frontier** of physics, at the **frontier** of mathematics, and at the **frontier** of computer science is the definition of a **polymath**. And a true supercomputer scientist.

Looking back **retrospectively**, computational fluid dynamics has a two-and-a-half century history. The two centuries between **1740** and **1940** were the era of **analytic fluid dynamics**. During that era, **partial differential equations** that govern the motions of fluids—such as **Euler’s equations**—only lived in obscure academic journal papers. Or on the mathematician’s blackboard. Such equations were never **discretized** and **coded** for the motherboard. Or for the evening weather forecaster.

## Unleashing the Power of Parallel Computing as the New Mathematics

For the fifteen years following June 20, 1974, at 1800 SW Campus Way, Corvallis, Oregon, USA, I grew from being one of the time-sharing programmers of one of the world's fastest computer that was powered by only one central processing unit to prevailing as the only full-time programmer of sixteen of the world's state-of-the-art supercomputers that was each powered by up to sixty-four binary thousand central processing units.

I theorized the world's fastest computer as powered by an Internet that is a global network of up to one billion processors. That was how I was a "discovered" as the only **father of the Internet** that invented an internet, in **1974**.

Mathematics is taught to every student. It's a mandatory subject during the first twelve years of schooling. But the mathematics learned in school was developed one to five thousand years ago. The world's fastest computing, as it's known today and as it's expected to be known tomorrow, is a new mathematical knowledge that came of age on July 4, 1989, the date I discovered it.

Parallel supercomputing is my **contribution** to mathematics. Supercomputing is the **invention** and **milestone** that **changed the way** the modern mathematician solves his or her most compute-intensive problems.



## UNLOCKING THE POSSIBILITIES OF PHYSICS

In school essays, an often-asked question is this: “What are the contributions of Philip Emeagwali to physics?” Please allow me to quote myself from a lecture that I gave to research physicists, in the early 1980s.

“The governing partial differential equations of gas dynamics were invented from the laws of conservation of mass, momentum, and energy. The number of partial differential equations is less than the number of dependent variables in the equations.

To complete the system of equations demanded we introduce an equation of state. Like the ideal gas law that introduces temperature as a new dependent variable. Doing so, requires we introduce another equation of state.

Substantial progress in developing partial differential equations was made during the hotbed of research activities that occurred during the 75 years that were inclusive of 1840 through 1915. That was the period the Navier-Stokes equations and analogous partial differential equations that govern the motions of fluids were formulated. During those seventy-five years, the practicing engineer only used algebraic and differential equations for his fluid dynamics calculations.

An often used equation was the Bernoulli equation that’s a nonlinear differential equation of the first order. During those years, the abstract governing partial differential equations of analytical fluid dynamics remained as textbook abstractions.”

### My Retrospective on Computational Physics

Without the programmable computer that came into existence from 1946 onward, there will be no computational fluid dynamics, and no weather forecasts. And the analytical fluid dynamics of the pre-computer era will remain in pure mathematics that remains of interest only to mathematicians and physicists that were within academia.

Retrospectively, we had two hundred years—from 1740 to 1940—of analytical fluid dynamics. The experimental fluid dynamics that was extensively investigated by Leonardo da Vinci in the late 15<sup>th</sup> century, was

followed by the analytical fluid dynamics of 1740 through 1940. And then followed by the computational fluid dynamics of the 1950s, 60s, and 70s.

And, finally, followed by the extreme-scaled massively *parallel-processed* fluid dynamics that was in the news because I discovered it when I executed it **across** an ensemble of 65,536 coupled processors, on July 4, 1989, in Los Alamos, New Mexico, USA.

## The Nine Philip Emeagwali Equations

Because this system of **partial differential equations** was beyond the frontier of calculus and encoded physics's second law of motion, it's used to predict the flows of crude oil, natural gas, and injected water flowing **across** a **highly anisotropic** and **heterogeneous** producing oil field. The system of coupled and nonlinear **partial differential equations** which governs an initial-boundary value problem at the frontier of calculus and computational fluid dynamics that represents the Earth is the tool used to predict the **long-term planetary motions** of air and water. Such planetary motions are the essences of climate models. We can predict atmospheric and oceanic motions and do so with the accuracy physics's second law of motion is used to predict the future positions of the Moon and Sun.

The nine Philip **Emeagwali** equations **are as reliable as a hammer**. My **contribution** to mathematics **is this**: I extended the borders of mathematical knowledge by a distance of thirty-six partial derivatives of calculus. The **partial derivatives** of calculus measure changes in properties, such as velocities, pressure, and friction. The computed solutions to a system of nonlinear **partial differential equations** that governs an initial-boundary value problem, called petroleum reservoir simulation, correspond to the flow of crude oil, natural gas, and injected water that flow up to **7.7 miles** (or 12.4 kilometers) deep. The depth of an oil well is up to eight times the length of the Second Niger Bridge of Nigeria. An oil field is about the size of my hometown, **Onitsha, Nigeria**.

## How Did Philip Emeagwali Impact Mathematics?

A question in school essays on famous mathematicians and their contributions to mathematics **is this**: “**What are the uses of the Philip Emeagwali equations?**”

Each time you ride in a car you did so because the **new knowledge** that I **discovered** on the Fourth of July 1989 was used to pinpoint the locations of crude oil and natural gas. I was the **first** to **discover** how the petroleum

industry could use millions of processors to solve a system of **trillions** of equations of algebra. Such algebraic equations arise during the computations of the miles-deep **subterranean** flows of crude oil and natural gas.

Such large-scale algebraic problems can only be solved **across** the millions of processors that power the world's most powerful supercomputers. State-of-the-art supercomputers are used to **discover** and **recover** crude oil and natural gas that were buried up to **7.7 miles** (or 12.4 kilometers) deep. Without the supercomputer, such crude oil and natural gas would remain **undiscoverable** and **unrecoverable**.

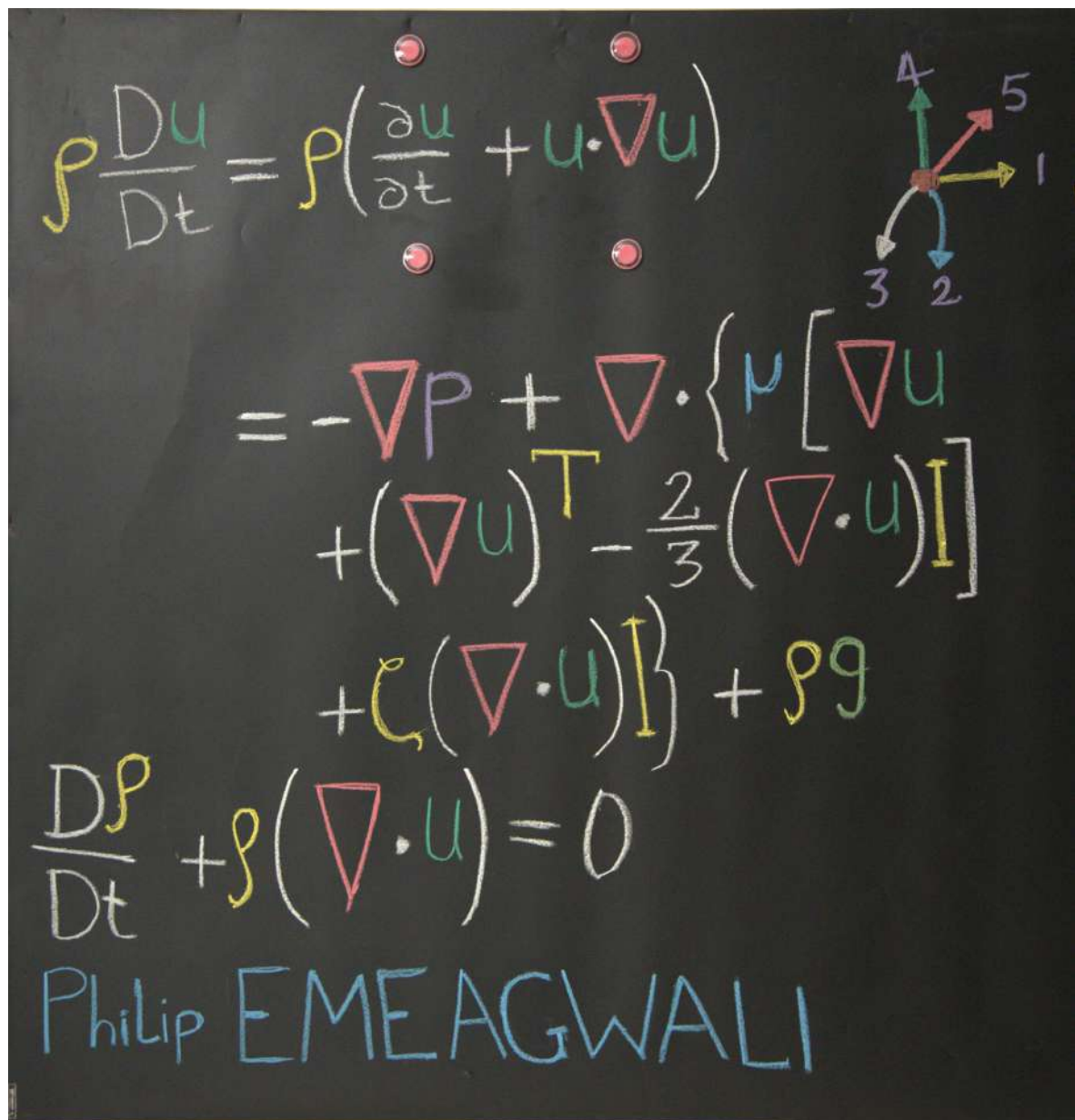
As an analogy, **the supercomputer is to the geologist or meteorologist or physicist or mathematician what the telescope is to the astronomer**. Just as the world's biggest telescopes are used to locate distant stars, the world's fastest computers must be used to pinpoint the locations of crude oil and natural gas that are deposited up to 7.7 miles deep.

I used the word "**algebra**" a thousand times in the one thousand lectures that I posted as podcasts and on YouTube. The reason was that I **discovered** how to solve a system of equations of linear algebra. I also **discovered** how to solve those equations **across** a new global network of up to one billion processors. I visualized my network as my **new Internet**.

## When Fiction Becomes Science

When I was coming of age as a supercomputer scientist and in the 1970s and 80s, the first world's fastest computing across the world's slowest processors was an **unconfirmed theory**. Before my **discovering** the world's fastest computing, which occurred on July 4, 1989, how to solve the most compute-intensive problems **wasn't** known, **wasn't** taught, and **wasn't** in any mathematics or physics or computer science textbook and examination.

Before my **discovery**, the fastest computing **across** the slowest processors only **existed** in **science fiction**. Making that **science fiction** to become **nonfiction** felt like a **benediction** when I and my discovery were validated, in 1989, with the highest award in supercomputing. It made the **news** headlines because I was unknown and won that award alone.



The image shows a chalkboard with several equations and a diagram. The equations are written in yellow and red chalk. The diagram shows a central point with five vectors labeled 1, 2, 3, 4, and 5. Vector 1 is yellow and points right. Vector 2 is blue and points down. Vector 3 is purple and points down-left. Vector 4 is green and points up. Vector 5 is red and points up-right. There are also two curved arrows around the point, one blue and one purple.

$$\rho \frac{Du}{Dt} = \rho \left( \frac{\partial u}{\partial t} + u \cdot \nabla u \right)$$

$$= -\nabla P + \nabla \cdot \left\{ \mu \left[ \nabla u + (\nabla u)^T - \frac{2}{3} (\nabla \cdot u) \mathbf{I} \right] + \zeta (\nabla \cdot u) \mathbf{I} \right\} + \rho g$$

$$\frac{DP}{Dt} + \rho (\nabla \cdot u) = 0$$

Philip EMEAGWALI

The equations behind fluid dynamics throughout the universe.

## DISCUSSION QUESTIONS 1/2

1. What were the key events and battles that made Onitsha the bloodiest battlefield in Africa during the Nigeria-Biafra War?
2. Describe the role of Colonel "Hannibal" Achuzie in the war and his tactics on the battlefield.
3. How did the Nigerian Army's superior firepower contribute to the defeat of Biafran soldiers?
4. What impact did the war have on the civilian population in Onitsha and other parts of Biafra?
5. How did the closure of schools in Biafra during the war affect the education system and the lives of young people?
6. What were the reasons for the frequent displacement of the author's family as refugees during the war?
7. How did the Nigerian Army's capture of Abagana contribute to the decision to flee Onitsha?
8. Describe the conditions and experiences of the author and his family as refugees in Onitsha and other locations.
9. What were the consequences of the Nigerian Army's capture of Onitsha for the population and infrastructure of the city?
10. How did the actions of Colonel Achuzie and other Biafran soldiers contribute to the high casualty rate among Biafran soldiers?
11. Discuss the significance of the Nigerian-Biafra War as the second bloodiest war in Africa's history.
12. What factors led to the outgunned and disorganized state of the Biafran Army during the war?
13. How did the use of British armored cars and Russian fighter jets contribute to the intensity of the final invasion of Onitsha?
14. Discuss the impact of the war on the ethnic Igbo population, particularly in terms of casualties and displacement.
15. How did the loss of Nigerian soldiers trapped in downtown Onitsha influence the retaliatory actions of the Nigerian Army?
16. What were the motivations behind the author's desire to leave Nigeria and pursue education in the United States?
17. Explain the author's role in pushing the boundaries of supercomputing and his contributions to the field.

18. How did the author overcome obstacles and discrimination as a Black supercomputer scientist in the United States?
19. Discuss the importance of supercomputers in industries like energy and geoscience, using Nigeria as an example.
20. How did the author's research in fastest computing challenge established theories and contribute to the field of physics?
21. What obstacles did the author face in conducting his research on fastest computing, and how did he overcome them?
22. Explain the significance of computational hydrodynamics and its applications in predicting fluid flows in oil fields and climate modeling.
23. How did the author's experiences working with hydroelectric dams contribute to his understanding of computational hydrodynamics?
24. Discuss the role of the author's equations and computational methods in the field of mathematics and solving complex problems.
25. Reflect on the impact and legacy of the author's contributions to mathematics, physics, and computer science.

## DISCUSSION QUESTIONS 2/2

1. What was the significance of Onitsha during the Nigeria-Biafra War?
2. How many soldiers were killed in the battle of October 12, 1967?
3. What role did Colonel "Hannibal" Achuzie play in the war?
4. Why did the Biafran Army use the refugees in Onitsha as human shields?
5. How does the Nigeria-Biafra War rank among the bloodiest wars in Africa?
6. What were the conditions like in Onitsha during the war?
7. Why were the Biafran soldiers outgunned and outnumbered during the war?
8. What weapons and support did the Nigerian Army receive during the invasion of Onitsha?
9. How did the war affect the civilian population in Onitsha?
10. Why did the author's family have to flee multiple times during the war?
11. What happened to the Nigerian soldiers trapped at the east bank of the River Niger in Onitsha?
12. How did the war impact the population of Onitsha?
13. Why did the author decide to pursue a scholarship in the USA?
14. How did Philip Emeagwali contribute to the field of supercomputing?
15. Why are supercomputers used in Nigeria, particularly in the energy and geoscience industries?
16. How did Philip Emeagwali overcome obstacles as a Black supercomputer scientist?
17. What challenges did he face in his research and career?
18. How did Philip Emeagwali's discoveries in computing challenge existing theories and textbooks?
19. How did he use computational hydrodynamics in his work on hydroelectric dams?
20. What was the significance of Philip Emeagwali's fastest computing discovery in 1989?

21. How did Philip Emeagwali extend the borders of mathematical knowledge?
22. How did his contributions impact the field of computational physics?
23. How did Philip Emeagwali's equations contribute to predicting the flow of crude oil and natural gas?
24. What role did supercomputers play in his research and discoveries?
25. How did Philip Emeagwali's work in supercomputing and mathematics impact the world?



## 2ND LECTURE: A NEW WAY OF SEEING EMEAGWALI INTERNET



Philip Emeagwali: "I am the only father of the Internet that invented an Internet."

**Broadcast 2 October 2021**

<https://youtu.be/pzbNasO1sFk>

## FASTEST COMPUTING FROM SLOWEST PROCESSORS

### Unlocking the Limitless Possibilities of the World's Fastest Computer

**M**y quest for the world's fastest computer began on June 20, 1974, on a scalar supercomputer at 1800 SW Campus Way, Corvallis, Oregon, USA. My quest was to be the first to fully understand how an ensemble of up to a billion processors can work together to solve the most compute-intensive problems and thus make the computer super. That quest began on the central processing unit of a supercomputer that was ranked as the world's fastest computer, seven years earlier.

My search was for the fastest computation of an initial-boundary value problem that was beyond the frontier of calculus and fluid dynamics. The perennial list of the most compute-intensive problems includes climate modeling across millions of processors. High-stake climate models are governed by a system of coupled, nonlinear, three-dimensional, and time-dependent PDEs, or partial differential equations, or rather, governed by discrete approximations of those PDEs that were used to translate the continuous problem from calculus to its discrete analog in large-scale computational linear algebra.

My search for the most massively parallel-processed solutions of the most compute-intensive problems in mathematical physics was my search for the answer to the most recurring question in supercomputing. That unanswered question was classified by the U.S. government as a Grand Challenge problem of supercomputing at the crossroad where the frontiers of knowledge in mathematics, physics, and fastest computing intersect.

My discovery that the world's fastest computing can be executed across the world's slowest processors occurred at fifteen minutes after 8 o'clock on the morning of July 4, 1989, in Los Alamos, New Mexico, USA. Before my supercomputing discovery, no mathematician or physicist or computer scientist could answer that big question.

### Leapfrogging from Slowest Processing to Fastest Computing

The story of how the fastest computer was invented from harnessing the **slowest** processors was incomplete. That story remains incomplete because a new **answer** brings forth a new **question**. My answer to how to solve the most compute-intensive problems and solve them by supercomputing **across** the **slowest** processors brings forth the new question of how to solve

the same initial-boundary value problems—such as large-scale computational fluid dynamics—and solve them fastest on a [quantum](#) computer.



Philip Emeagwali, Cambridge, MA, November 30, 1990.

### The Nine Philip Emeagwali Equations

Students are asked to write a short essay on the nine **Philip Emeagwali** equations. This essay question will not be dated in five thousand years. Technology does not age well. The vector supercomputers, of the 1970s and 80s, were replaced by the world's fastest computers of today.

Science ages well. Mathematics ages well. **Pythagoras** theorem **predates** Pythagoras by one thousand years. **Pythagoras** theorem was known during the reign of **Hammurabi** the Great. Therefore, the **nine Philip Emeagwali equations** will **not** become **obsolete**, just like **Pythagoras** theorem, that has been known for four thousand years, didn't become **obsolete**.

I write equations, algorithms, and programs, daily. I write equations the way **poets** write **poems**. A supercomputer scientist proves he understands the **partial differential equation** that is beyond the frontier of calculus, or mathematics and physics textbooks, and does so **if and only if**, he can explain his equation on YouTube. And **if and only if** he can code the solution of an initial-boundary value problem that was governed by his **partial differential equation**. And **if and only if** he can email the initial and intermediate boundary conditions and email them to and from the millions of processors that **outline** and **define** his or her massively parallel supercomputer.

I visualized my new supercomputer as a new Internet that's my new global network of processors that's not a computer, by its very nature. It's a **new Internet**, in reality. I'm the only **father of the Internet** that invented an Internet.

## Why I Invented the Nine Philip Emeagwali Equations

Fast-forward eight years after June 20, 1974, in Corvallis, Oregon, USA. I was in the nation's capital of Washington, D.C. During the first half of the 1980s, I lived and conducted supercomputing research in the three Maryland cities of Baltimore, Silver Spring, and College Park.

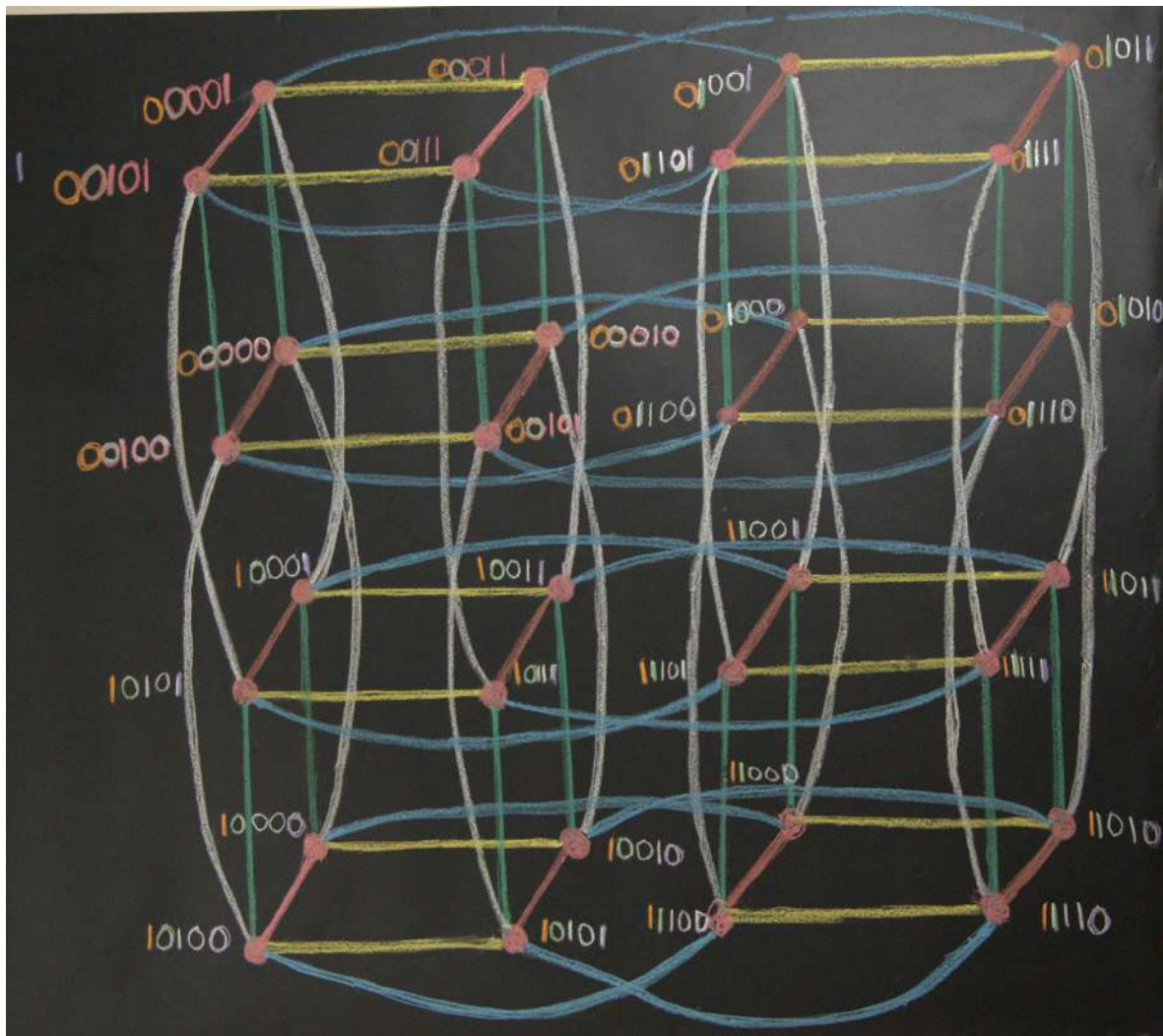
During the two decades that followed 1970, I grew in my knowledge of mathematics, physics, and computer science. By the late 1980s, I was standing alone at the frontier of knowledge of how to manufacture computers that are powered by a billion processors. And that can compute a billion times faster.

That was the reason I received invitations to give lectures on my theoretical discovery of how I'll massively parallel process. And solve the most compute-intensive mathematical problems in meteorology and geology. And solve them **across** millions of off-the-shelf processors that **shared nothing**.

I **discovered** how to solve the most compute-intensive problems in extreme-scale computational fluid dynamics, such as modeling hurricanes and tornadoes. And doing so to protect life and property. And designing hypersonic airplanes, quiet submarines, and efficient automobile bodies. But in the early 1980s, my supercomputing lectures were **dry** and **abstract**.

In the 1980s, my reformulations, discretizations, and stability analyses of my new system of partial differential equations were impenetrable to the layperson. In the 1980s, my world's fastest computing quest was to translate the nine Philip Emeagwali equations which I invented on the blackboard. And code their discretized, algebraic approximations on a never-before-seen motherboard.

My new motherboard was a new Internet that was a new global network of 65,536 coupled, off-the-shelf processors. I visualized those processors as identical and as uniformly and tightly encircling a globe. And I visualized my globe as embedded within my sixteen-dimensional hyperspace. Furthermore, I visualized those two-raised-to-power sixteen processors as defining and outlining a new Internet. And doing so just as computers encircle the Earth and define and outline the Internet.



Philip Emeagwali's visualization of the five-dimensional subset of his 16-dimensional supercomputer network.

Unlike other research computational mathematicians, of the 1970s and 80s, I believed that my mathematical script should be **heard** on the stage (or on the **motherboard**) rather than **read** on the page (or on the **blackboard**). The computer is to the **partial differential equation** what the microphone is to the poem.

I was not an overnight success. I've been supercomputing for the fifty years onward of June 20, 1974, in Corvallis, Oregon, USA. **The chicken does not lay its egg and hatch it the next day.** I progressed from the analytical fluid dynamics of the 1970s to the large-scale computational fluid dynamics of the 1980s. In 1974, in Corvallis, Oregon, **USA**, I wrote supercomputer codes for one processor. And for solving a huge system of equations of algebra. Over the two decades, from 1970 to 1990, I grew in my scientific knowledge and mathematical maturity. I grew from merely knowing the second law of motion described in physics textbooks.

That law was discovered, in prose, three centuries and three decades ago. I grew from knowing that law only in prose and algebra to encoding that law into the nine **partial differential equations** called the Philip **Emeagwali equations**. My equations govern the three-phased flows of crude oil, injected water, and natural gas that flow along three dimensions and **across** porous media that're both **heterogeneous** and **anisotropic**.

I developed the mathematical maturity and the knowledge that I used, in the early 1980s, to **discretize** and **analyze** the **consistency**, **stability**, **convergence**, and the **error propagation rates** of my new finite difference discretizations of the linearized nine Philip **Emeagwali equations**.

I think of myself as a mathematician, first. The twelve-year-old writing an essay on famous inventors think of me as a computer scientist, first. But some old friends remember me as a physicist or an engineer. **What's the difference between scientific research and engineering practice?** To discover is to make the unknown know. For that reason, the research scientist should not know what he's doing. But the Chief Engineer for the mile-long Second Niger Bridge in Nigeria must know what he's doing.

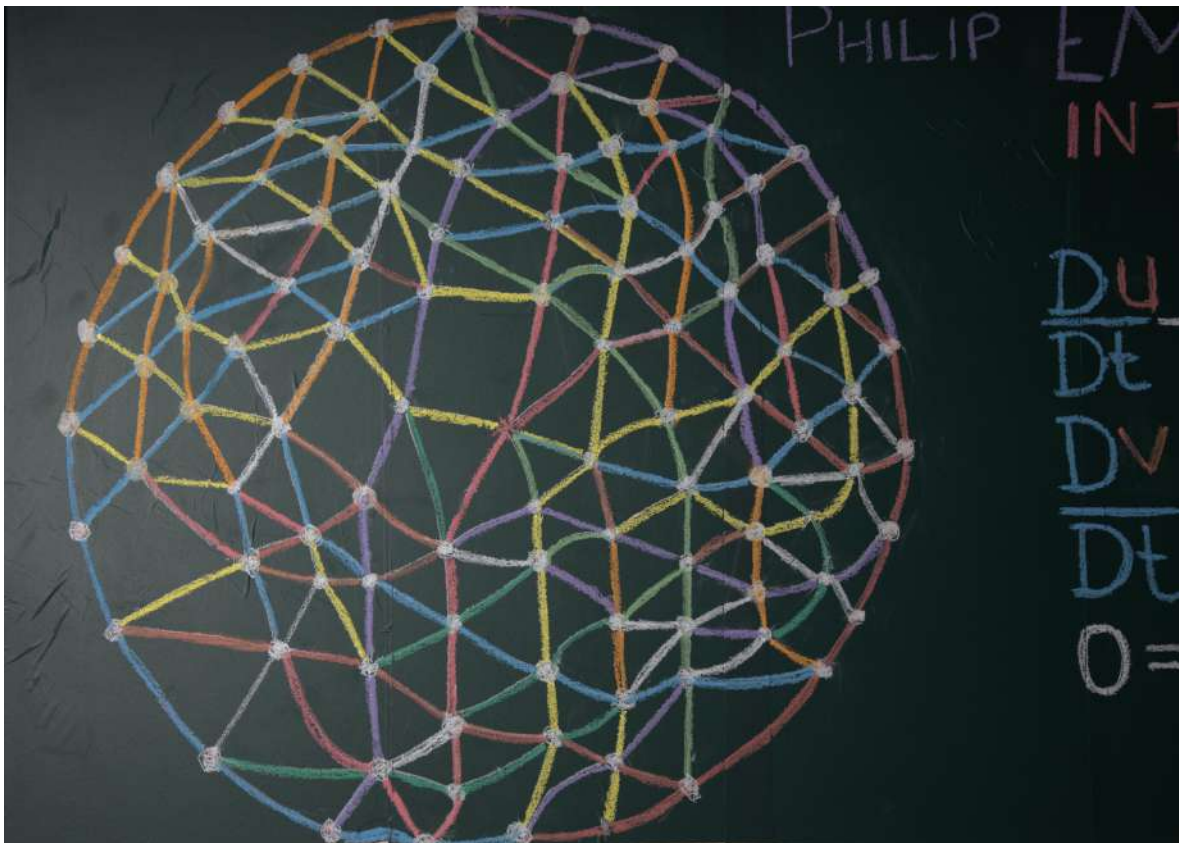
**Why should someone, like myself, spend fifty years learning what is already known and trying to make the unknown known?** That's like asking: Why should a six-year-old learn how to add and subtract, which is already known? The up-and-coming supercomputer scientist must have her eyes fixed on how to scale new summits, such as solve the **most difficult** problems in science, engineering, and medicine. And solve them on a quantum computer.

## PHILIP EMEAGWALI INTERNET

### My Eureka Moment

**T**he Eureka moment, or high point, of my quest for the fastest computer in the world occurred on July 4, 1989, in Los Alamos, New Mexico, USA. And it occurred across my ensemble of the slowest 65,536 processors in the world.

I **invented** a new Internet that consisted of sixty-four binary thousand processors (or, equivalently, 65,536 computers) that were uniformly distributed **across** the surface of a globe. That new global network of 65,536 processors was my small copy of the Internet that is a global network of computers. My new global network of up to a billion processors that uniformly encircled a globe, in any dimension, is called the Philip Emeagwali **Internet**.



Philip Emeagwali's back-of-the-envelope sketch of the blueprint for his supercomputer that is also an Internet.

## Supercomputing Compute-Intensive Problems

In 1989, my sixty-four binary thousand processors communicated via emails that contained 65,536 fluid dynamics codes that I sent from up to sixteen closest-neighboring processors. My computer codes and email primitives were **esoteric** and weren't meant to be read by humans.

I was computing at the world's fastest speeds back from June 20, 1974, in Corvallis, Oregon, USA, to July 4, 1989, in Los Alamos, New Mexico, USA. In that decade and half, I observed that nine out of ten supercomputer cycles were executed by large-scale computational physicists who used the supercomputer to execute their computational fluid dynamics codes. And do so for the greatest accuracy and the highest model resolution.

In the 1970s and 80s, the **poster boy** of extreme-scale computational fluid dynamics codes was the global climate model that must be used to **foresee** otherwise **unforeseeable** centuries-long global warming. In those two decades, short-term weather forecasts and long-term climate studies consumed **five percent** of all supercomputer cycles.

The poster girl of computational fluid dynamics supercomputer codes was the petroleum reservoir simulation that must be used to **hindcast, or re-forecast**, how to **recover** otherwise **unrecoverable** crude oil and natural gas that are often buried up to **7.7 miles** (or 12.4 kilometers) deep. And buried **across** an oil-producing field that's about the size of **Johannesburg (South Africa)**. Petroleum reservoir simulation, alone, consumed ten percent of all supercomputer cycles.

### Where Are the Fastest Computers?

I began programming the fastest computers, on June 20, 1974, in Corvallis, Oregon, USA. Back then, my theory of fastest computing **across** a billion processors was in **science fiction** and not in science textbooks. And solving the most compute-intensive problems by dividing-and-conquering them **across** a billion processors was an **unexplored field of knowledge** that wasn't then on the map of computer science.

In 1974, my theory of the **fastest** computing **across** the **slowest** processors **evoked laughter**. Back then, the supercomputer of today that's powered by millions of processors only existed as a **science-fiction** technology that had no programmer or **prophet**. In the 1970s, the vector supercomputer was the accepted technology for all supercomputing. Back then, vector processing had twenty-five thousand **evangelists**.

The **two titans** of the supercomputer world were **Gene Amdahl** of Amdahl's law fame and **Seymour Cray** the pioneer of vector supercomputers. In the 1970s and 80s, the most **revered prophet** of vector supercomputers was **Seymour Cray**, the founder of Cray Corporation, the company that manufactured seven in ten vector supercomputers.



In the 1960s and 70s, the most revered prophet of scalar supercomputers was **Gene Amdahl** of **Amdahl's law** fame. **Gene Amdahl** was the supercomputer manager at International Business Machines (IBM) Corporation, the company that now manufactures the most supercomputers sold in the USA.

### **Black in All-White Supercomputing Community**

As a Black sub-Saharan African mathematician who came of age in the 1970s Oregon and **negatively typecast** in the mid-1980s Michigan, I gained credibility as a “**genius**” because I presented a never-before-seen supercomputer. And presented the technology in both prose and poetry and straight from the heart.

Unlike the academic mathematician, I did not read the nine **Philip Emeagwali** equations and their nine companion **Philip Emeagwali** algorithms and did not copy them from any textbook. The Black mathematician is judged by a higher standard. That meant that I had to develop ways for solving the **most difficult** problems at the intersection where new physics, new mathematics, and new computing **intersected**.

I did not solve the Grand Challenge problem on the blackboard, alone. I solved it **across** a **new Internet** that's a new global network of millions of coupled processors. For that contribution to science, I won the highest award in supercomputing. Computer scientists refer to my award as the Nobel Prize of supercomputing.

I stood out because I was a Black mathematician and **the inventor of supercomputing via parallel processing** who computed alone. Furthermore, I came of age in the 1970s and 80s and within a nearly all-white male supercomputing community. As a young Black and African supercomputer scientist, I was compelled to conduct my physics and mathematics research alone.

My approach differed from working within a multidisciplinary team of one thousand specialists. I had to do my research as an outsider to all the companies like Cray, Intel, or IBM (or International Business Machines) corporations. I was unknown for the fifteen years that followed June 20, 1974, the day I first programmed one of the world's fastest computers. During those fifteen years, I grew in my mathematical and scientific maturity.

And I programmed thousands of processors that I visualized as encircling a globe and doing so in the manner the **Internet now encircles** the Earth. I was the **first** to parallel process computational fluid dynamics codes at world record speeds. And solve them **across** a new Internet that's a new global network of off-the-shelf processors.

My **contribution** to technology was not a minor increase in the speed of the computer. My world record speed made the **news** headlines because solving the most compute-intensive problems **across** millions of processors

was a **radical change** in how we do mathematics. And look at the world's fastest computer in a new way.

During my first fifteen years of supercomputing, I grew in my scientific knowledge and mathematical maturity. I theorized new knowledge that could make the computer faster when powered by the **slowest** processors in the world. I theorized that the then unproved technology of parallel supercomputing could be used to solve 65,536 computational fluid dynamics codes. And solve them all **simultaneously**. And communicate them **across** 65,536 coupled processors.

In the 1970s, I theorized the **fastest** computing **across** the slowest processors. In the 1980s, I experimented with parallel processing **across** the slowest 65,536 processors in the world. The reason I experimented alone, with the **slowest** processors, was that the luminaries in the world of supercomputing joked that **fastest computing by slowest processing will forever remain a beautiful theory that will always lack experimental confirmation**.

### Philip Emeagwali Lectures

In 21<sup>st</sup> century science, the highest awards are supported with YouTube lectures. I've posted one thousand podcasts and closed-captioned videos on YouTube that each described my contributions to physics, mathematics, and computer science. The award lecture is to the historian of science what the SAT (or Scholastic Aptitude Test) is to the American university admission officer. Or what the **LSAT** (or Law School Admissions Test) is to the American Law School admission officer. Or what the JAMB (or Joint Admissions Matriculation Board) is to the Nigerian university admission officer.

A perfect score in the SAT, **LSAT**, or JAMB tests does not make a candidate the smartest person in the world. In the U.S. alone, about **thirty-five thousand** living Americans achieved a perfect score in their SATs. The highest awards in the fields of mathematics, physics, and computer science are given based on the discoveries and inventions contributed by the recipients and documented on YouTube.

In 1989, my contribution of the world's fastest computing made the **news headlines**. And earned me an award that computer scientists refer to as the **Nobel Prize of supercomputing**.

Once in a century, an invention **changed the definition** of computer science. A **radical shift** in how we solve the most compute-intensive

problems is a **contribution** that extended the frontiers of mathematical knowledge. And resulted in **revising** mathematics textbooks. The lectures of well-known scientists of modern times, such as **Albert Einstein**, who is considered the **father of modern physics** are posted on YouTube.

I followed that scientific tradition by posting on YouTube one thousand closed-captioned podcasts and videos. Each podcast or video that I posted on **YouTube** described my contributions to physics, mathematics, and computer science. My video series on my inventions is the largest set of transcribed lectures ever posted on YouTube by a single inventor. Yet, I feel like I have ten thousand unrecorded videos inside me.

## INVENTING A NEW COMPUTER SCIENCE

**P**arallel computing is the technological knowledge that enabled the computer that's powered by one thousand processors to be faster. And enabled the world's fastest computers that're powered by one billion processors to be fastest.

Once upon a time, before 1989 to be exact, the complete knowledge of the fastest computing across the slowest processors wasn't in supercomputer textbooks. During that era of darkness, the world's fastest computer, as it's known today, existed only in science fiction. I invented the first supercomputing across the world's slowest computers. And discovered it on July 4, 1989. That is, the computer scientist learned modern supercomputing because and after I invented it. And the computer instructor is teaching the world's fastest computing that I invented. The science teacher renounced his voice to give voice to the discoverer.

The computer architect or physicist or mathematician knows the world's fastest computing only after it was discovered and entered into textbooks. At its granite core, fastest computing is the knowledge of how to solve a billion mathematical problems **simultaneously**. In the past, supercomputing was solving only one difficult mathematical problem at a time.

The difference between the **author** and the **inventor** is this: The author of a science textbook is [like the ghost writer who authored the story he didn't live](#). Or like the fifth-grader who wrote a book report on a book he didn't read. [I'm fastidious in describing and videotaping my contributions to mathematics, my discoveries in physics, and my inventions in computer science. I do so as a preemptive measure against those that want to occupy my stage and tell my story.](#)

### Einstein Versus Emeagwali

In a 60-year retrospective, I realized that I spent the first half of my life wishing I was the **Albert Einstein** that theorized **relativistic** motions of distant planets. [And then spent the second half of my life wishing I was my younger self who discovered how to compute at the fastest speeds the motions of planetary fluids.](#) To benefit posterity, I posted one thousand videotaped lectures in which I explained my discoveries and inventions. At its [essence](#), my 1,000-part videotaped lecture series was an attempt [by the old Philip Emeagwali to record the story of the young Philip Emeagwali.](#) The knowledge possessed by a theoretical physicist, such as **Albert Einstein**, or a computational physicist, such as **Philip Emeagwali**, can

only be evaluated and compared from watching their videotaped lecture series on their discoveries in physics. The one thousand podcasts and videos of myself as the extreme-scale computational physicist are on YouTube. The videotaped lectures of the likes of the theoretical physicist **Albert Einstein** are the most truthful, irrefutable, and permanent measures of their intelligence and scientific knowledge and their understandings of their contributions to knowledge.

## Emeagwali YouTube Channel

I've posted on YouTube the details of how I discovered that processing with up to a billion processors is the technology that makes computers **faster**. And makes the supercomputer the **fastest**. My technology is used to solve the most compute-intensive problems in science and mathematics. I've posted one thousand podcasts and YouTube videos on my contributions to science.

With 330 million people, the U.S. is only 4.3 percent of the world's population of 7.7 billion people. There are five thousand three hundred universities in the U.S. alone. And there are as many YouTube channels for those universities. In **YouTube** searches, **closed-captioned** and high-resolution videos are ranked higher. **Google** only searches the contents of **transcribed** videos. In **Google searching**, my **YouTube** channel "**Emeagwali**" has more **searchable video content** than the video channels of ninety-nine percent of the 30,000 universities in the world. I make such **asymmetrical** comparisons, between an individual and each of the 30,000 universities in the world because knowledge shared is knowledge gained. Knowledge sharing makes the world a better place for humans and for all animals. Sharing knowledge reflects leadership. The most important thing we can do with knowledge is to share it, not keep it. The **tagline** of *CNN* is **this**: "**When we know it, you'll know it.**" I hope that in my 200<sup>th</sup> birthdate, on August 23, 2154, that my videos will be displayed.

## DISCUSSION QUESTIONS

1. What is Philip Emeagwali's claim regarding his role in the invention of the Internet?
2. How did Philip Emeagwali's quest for the world's fastest computer begin?
3. What problem was Philip Emeagwali trying to solve with his search for the fastest computation?
4. What is the significance of the nine Philip Emeagwali equations?
5. How did Philip Emeagwali leapfrog from slowest processing to fastest computing?
6. What is the connection between Philip Emeagwali's equations and Pythagoras' theorem?
7. How did Philip Emeagwali visualize his new supercomputer?
8. What was Philip Emeagwali's Eureka moment, and where did it occur?
9. What is the Philip Emeagwali Internet, and how does it differ from the traditional Internet?
10. How did Philip Emeagwali solve compute-intensive problems using parallel processing?
11. Where did Philip Emeagwali begin programming the fastest computers, and what was the prevailing technology at the time?
12. How did Philip Emeagwali's race and background influence his journey as a supercomputer scientist?
13. What role did parallel computing play in Philip Emeagwali's invention?
14. How did Philip Emeagwali's contributions to supercomputing impact the way we solve compute-intensive problems?
15. What awards and recognition did Philip Emeagwali receive for his contributions to supercomputing?
16. How did Philip Emeagwali utilize YouTube to share his knowledge and contributions?
17. What are the differences between the author and the inventor, according to Philip Emeagwali?
18. What did Philip Emeagwali discover about processing with a billion processors and its impact on computer speed?

19. How does Philip Emeagwali compare himself to Albert Einstein?
20. What is the significance of Philip Emeagwali's YouTube channel in terms of knowledge sharing?
21. How does Philip Emeagwali's YouTube channel compare to university channels in terms of searchable video content?
22. Why does Philip Emeagwali believe that sharing knowledge is essential?
23. How does Philip Emeagwali view the relationship between knowledge and leadership?
24. What is the tagline of CNN that Philip Emeagwali references in the text?
25. What is Philip Emeagwali's vision for the future of his videos and their display on his 200th birthdate?

### 3RD LECTURE: CRAFTING THE FASTEST COMPUTERS



**Broadcast 2 October 2021**

<https://youtu.be/unw7R1tTR48>



## THE FIRST SUPERCOMPUTER

**M**y contribution to the development of the first supercomputer is this: I invented the first world's fastest computing, as it's executed today.

Because I invented a supercomputer where none existed, I can confidently say that: "After the Fourth of July 1989, an ensemble of the slowest processors in the world can work together to emulate a never-before-seen supercomputer."

As the inventor of the world's fastest computing, my lectures had power and focus. The reason was that only I could give a **first-person** eyewitness account of that **seminal moment** in the history of the computer. That Eureka! moment was **fifteen** minutes after 8 o'clock on the morning of July 4, 1989. When I give advice on how to invent the world's fastest computing, or supercomputing, or solving difficult problems **across** a new Internet that's a new global network of processors, I speak from my unique experience of being the only inventor that invented such technologies.

My knowledge was **diametrically opposite** to that gained from reading about supercomputers. As well as reading from textbook authors who were describing the inventions of computer pioneers. After half a century of supercomputing, I acquired a deep knowledge that enables me to produce the one thousand podcasts and YouTube videos in which I lectured **impromptu**. I discovered the world's fastest computing and did so without notes that were copied from textbooks.

For the record, the world's fastest computing community of the 1980s was comprised of only one member within parallel supercomputing. And twenty-five thousand members within vector supercomputing. In the 1980s, I was the only person in parallel supercomputing that executed the world's fastest computing.

My **discovery** of the world's **fastest** computing **across** the world's **slowest** processors is my **contribution** to the development of cheaper and faster computers. The world's fastest computing wasn't just a technology that I invented. It's who I am.

For nearly every day of the past half century, since June 20, 1974 to be exact, I conducted mathematical research on how to harness up to one billion processors that encircled a globe as an Internet. And use them as one cohesive supercomputer. The fastest computers are used to answer the biggest questions in science, engineering, and medicine. Such questions include supercomputing the social distancing requirements during a global pandemic. For those reasons, the world's fastest computing will remain at the core of who we are.

The world's fastest computing is used to find answers to big scientific questions that are central to tackling the global challenges that face humanity, such as supercomputing the social distancing that reduces the spread of coronavirus. The world's fastest computing **across** the world's slowest processors is a **transformational** discovery that **redrew the boundaries of science**, and **permanently changed** what we know about the computer. And how we think about mathematics.

The world's fastest computer is powered by millions of processors. And the hardest problems in mathematics and physics are solved by dividing each grand challenge problem into up to a billion less challenging problems. And then solving them in **tandem**. And with a **one-to-one** correspondence with as many processors.

The grand challenges of supercomputing are the most pressing problems of our time. One such challenge is to execute the detailed computational fluid dynamics model of the spread of the coronavirus **across** the one million **shoulder-to-shoulder** traders in Lagos markets. Fastest computing **across** millions of processors is the path to the solution of the most difficult problems arising at the crossroad where new physics, new mathematics, and new computing **intersected**.

The invention of a new supercomputer led to the creation of the new computer science of parallel processing. That new science became an instrument of discoveries that transformed lives. The **Philip Emeagwali Computer** is a supercomputer that's developed in a **new way**, namely, powered by up to a billion processors. It's also a **new Internet** that's a new global network of up to a billion processors. Those processors **shared nothing but were in constant dialogue**.

The mathematician's perennial quest for the world's **fastest** computing constantly demands fresh faces, new names, and new ideas. During the decade and half onward of June 1974, I was an unknown supercomputer scientist. But I possessed the then unproven idea of harnessing millions of the world's **slowest** processors. And using them to cooperatively solve the **most difficult** problems in mathematics. Such compute-intensive problems could not be solved on a **single giant processor**.

When I began my mathematical quest—on June 20, 1974, in Corvallis, Oregon, USA—the world's **fastest** computing **across** the world's **slowest** processors was merely a theory, or an idea that's not positively true. Since 1974, I believed what I felt in my gut and know in my heart. I believed that harnessing the power of up to a billion processors will leave **science fiction** to become **reality**. And produce the world's **first supercomputer**, **as it's known today and as it could be known tomorrow**.

In computer science, recording the world's **fastest** computing and recording it in an unexpected way—such as **across** the world's **slowest** processors—is the gold standard that earns its inventor the highest award that's referred to as the Nobel Prize of supercomputing. I was the **first and only** person to win that award **alone**, in 1989.



Philip Emeagwali, 15 Edgewood Way, Corvallis, Oregon. late May 1975.

### One Day We Had to Run!

The period of early 1967 was an era of **widespread reprisal attacks** against Igbo-speaking people who were living in the northern region of **Nigeria**. In late September 1967, Igbo-speaking people who were living in the midwestern region of **Nigeria** were **killed in reprisal attacks** from the Midwest military invasion of the Biafran Army. In faraway Northern Nigeria, houses belonging to Igbos **were burnt**. And their stores **were looted**. **Igbos pursued by mobs** hid with **Hausa** friends. Some changed their Igbo names to **Hausa** names. In 1967, pursued **Igbos** in Northern **Nigeria** were smuggled into safer neighborhoods.

Back then, there was no **inter-city** bus transportation in **Nigeria**. My family travelled from Agbor to Onitsha in small **Peugeot** 403 sedans that squeezed in eight passengers. We also travelled by “*gwon gwo ro*,” a truck, a **rickety** lorry with a wooden body. Such **trucks** were used by market

traders for their long-distance transportation of farm produces, such as yams, chickens, and goats.

In early May 1967, the political crisis in **Nigeria** remained **unabated**. Within a six-month period, **Nigeria** lost two political leaders. The Prime Minister of **Nigeria**, **Abubakar Tafawa Balewa**, was **assassinated** on January 15, 1966. Six months later, the new military President of **Nigeria**, Major-General **Johnson Aguiyi-Ironsi**, was **assassinated** on July 29, 1966.

The **assassination** of the Prime Minister of **Nigeria** spurred **reprisal killings** of Igbo-speaking people who were living in the northern region of **Nigeria**. As the violence spread, Igbo refugees fled to their ancestral homelands. Reacting to the 30,000 Igbos killed in the street uprisings in Northern Nigeria which followed the second, **retaliatory** military coup of July 29, 1966, the *Daily Sketch*, a Lagos newspaper, pleaded for sanity in Nigeria. The *Daily Sketch* asked:

“Will no one save Nigeria?... Is there no one whose love for Nigeria transcends love of tribe or personal safety, who is willing to come forward and seek others like himself to nurse this sick nation? If there be a man, let him come forward. Today, for God's sake!”

My answer to the question “**Who will save Nigeria?**” is **this**: Nigeria cannot be saved by one **superhero**. Nigeria can be saved by 230 million **detrimentalized** Nigerians. Or heroes and heroines who don't vote along religious, ethnic, and regional sentiments. And who don't call for the **dissolution** of Nigeria into three countries, the republics of **Biafra**, **Oduduwa**, and **Arewa**. **The breakup of Nigeria is unacceptable to me.**

From January 1966 and **later**, tensions were high throughout Nigeria. In response, my father decided that **Agbor** was no longer safe for us to live in. We rented a **gwon gwo ro** to transport us from the Nurses' Quarters of the General Hospital, **Agbor**, to our second and safer residence at 4B Egbuna-Adazie Street, **Onitsha**. Onitsha was a commercial city that was 47 miles east of **Agbor**.

## A Refugee in Our Country

The seats of the **truck** were bare wooden planks and were very **uncomfortable**. The **gwon gwo ro** we rented was crammed with three

chairs, two beds, a double-barrel gun, a Raleigh bicycle, a singer-brand sewing machine, cooking utensils, and various household items. My family returned to **Onitsha** in early May 1967. **Onitsha** is our [historic homeland](#) at the east bank of the River Niger. Although **Onitsha** was only 47 miles away from **Agbor**, that journey took three hours.

From early May 1967 to the first artillery bombardment of **Onitsha** which occurred on the Fourth of October 1967, we lived in my parent's house that was at 4B Egbuna-Adazie Street, **Onitsha**. That house was built five years earlier. And my father stayed in the Nurses' Quarters of the [General Hospital, Agbor](#).

### The Midwest Invasion of 1967

He was in **Agbor** during the Midwest [invasion](#) of 1967. That [invasion](#) of the mid-western region of Nigeria was executed by 3,000 lightly armed Biafran soldiers. That invasion began at three o'clock on the morning of August 9, 1967. And began when **Biafran** soldiers [crossed](#) the [Onitsha-Asaba](#) bridge and occupied the entire Midwest Region. By 5:30 of that same morning, the regional headquarters of the Midwest Region, **Benin City**, was under the control of the **Biafran** Army.

### A Nigeria Divided into Three Nations

When we received the news that **Benin City** had been captured by the "[gallant Biafran soldiers](#)," we ran into the streets of **Onitsha** to celebrate that victory. On August 12, 1967, the Biafran Army captured the city of [Ore](#) that was deep inside the western region of **Nigeria**. In **Biafra**, the capture of [Ore](#) was [widely celebrated](#) as a [strategic victory](#). The capture of [Ore](#) placed the Biafran Army a mere [130 miles](#) from **Nigeria's** capital, **Lagos**. In **Onitsha**, we [speculated](#) that the civil war might not last long. And that the Nigerian Army will soon surrender to the Biafran Army.

The three thousand Biafran soldiers who [overran](#) the vast mid-western region of Nigeria were [lionized](#) as heroes. **Biafrans** were amazed that the mid-western region was captured within three hours. And captured without firing a single bullet. We were [surprised](#) by the [boldness](#) of those three thousand **Biafran** soldiers who captured the mid-western region of **Nigeria**.

Those **Igbo** soldiers were commanded by a **Yoruba** officer, named [Victor Banjo](#). Major-General Victor **Banjo** was a [disaffected](#) Yoruba soldier, who [defected](#) from the Nigerian Army to the Biafran Army. On August 9, 1967,

the day the Biafran Army captured the mid-western region of **Nigeria**, my father was in that region and was working as a nurse at the General Hospital, **Agbor**. The Biafran Army claimed to have “**liberated**” the mid-western region.

On September 19, 1967, the Biafran government renamed the mid-western region of Nigeria as the “**Republic of Benin**.” That same day, the Biafran leader, General **Odumegwu Ojukwu**, appointed Major-General **Albert Okonkwo** as the Military Administrator of the new **Republic of Benin**, between Biafra and Nigeria.

## THE EMEAGWALI INTERNET

### Achieving the Unimaginable

#### A New Way of Seeing

**T**he story of how I discovered the world's fastest computing across the world's slowest processors and across an Internet that is a global network of those processors began on June 20, 1974. My story began in a small room that was upstairs of a white house at 195A Knox Street South, Monmouth, Oregon, USA. Oregon is one of the whitest states in the USA. The city of Monmouth (Oregon) that I was living in had no resident Black couple. In 1974, I was a lone Black supercomputer geek in Oregon. And I programmed supercomputers at the same time Steve Jobs was a personal computer geek in Portland (Oregon).

#### Three Cornerstones of Supercomputing

Fast-forward sixteen years, and my story was in the **news**. My story that began in a small room in Monmouth (Oregon) was in millions of living rooms across the world. Physics, calculus, and algebra are the **three cornerstones** of fastest computing. The root of computing can be traced to the Middle Ages. The historical path to the world's fastest computing began 330 years ago. It began as the **discovery** of physics's second law of motion. It began as the **invention** of the technique of calculus that's the most powerful technique in mathematics.

#### Philip Emeagwali Internet

In the 1980s, the biggest challenge in computer science was to **invent** how to compute 65,536 times **faster**. And do so **across** a **new Internet** that I visualized as a **new** global network of 65,536 off-the-shelf processors and standard parts. That **new Internet** needed its first programmer who could harness it as the world's fastest computer. That first programmer must be a **triple threat** at the frontiers of in physics, mathematics, and computing.

## Supercomputing Across the Philip Emeagwali Internet

The intellectual and the physical instruments that were required to make those **mathematical** and **scientific discoveries**, such as the world's fastest computing, were the knowledge of the laws of classical physics, mastery of the **partial differential equations** arising beyond the frontier of calculus, knowledge of large-scale algebra, and the expertise of how to program a processor to solve the most difficult mathematical problems that are compute-intensive. And the knowledge of how to communicate via sixty-four binary thousand email addresses that each had no @ sign or dot com suffices. And how to exchange the initial and boundary conditions **across** one binary million bidirectional, regular, short, and equidistant email wires. And to, finally, compute **simultaneously** and do so at 65,536 off-the-shelf and coupled processors that **shared nothing**, but were in dialogue with each other.

## Physics is the Thread Across a Million Processors

The laws of physics are the essences and the **common thread** through the **partial differential equation** arising beyond the frontier of calculus, through the **partial difference equation** of large-scale algebra that approximates that **partial differential equation**, through the compute-intensive fluid dynamics code that was derived from that algebra and emailed **across** that small copy of the Internet that I invented as a global network of processors.

## Contributions of Philip Emeagwali to Science

A question in school essays **is this**: “What is the **contribution of Philip Emeagwali** to the development of the computer?”

In 1989, I was in the news because I **discovered** how to always perform the world's fastest computing. And how to record such speeds **across** an Internet that is a global network of the **slowest** processors in the world. My **contribution** to the development the world's fastest computer wasn't too small as a journal paper. Or too large as computer science.

In 1989, I was widely recognized for my **contribution** to a **new** and **critical** technology. That contribution is the world's fastest computing **across** the world's **slowest** processors. The **new knowledge** of the world's fastest computer that I **contributed** to computer science is used to manufacture the fastest computers of today which are expected to become the computers of



tomorrow. My **contribution** went beyond discovering an increase in the speed of the world's fastest computer. My **contribution** to developing the supercomputer included fighting **scientific dogmas**.

## Finding the Magic Sword for Supercomputing

I faced many **obstacles** during my fifteen-year quest to **discover** how fastest computing across a billion processors could become the **magic sword** to be used to solve the hardest problems.

For instance, on three occasions, in 1977, 1981, and 1989, when the word got out that I was conducting research on the world's fastest computing **across** the world's slowest processors, the governmental fellowships that partially supported my research were withdrawn. My fellowships were **cut off** as **retribution** and **punishment** for pursuing the fastest computer speed that was then in **science fiction**.

## Why is Mathematics Useful for Nigerian Oil Fields?

Two often-asked questions are these: First, how do we use mathematics in our everyday life? cond, why is mathematics useful in pinpointing the locations of crude oil and natural gas that were buried one mile deep in the Niger Delta oil fields of southern Nigeria.

The young African mathematician needs to understand those parallel-processed solutions used to **discover** and **recover** otherwise **undiscoverable** and **unrecoverable** crude oil and natural gas that are buried up to **7.7 miles** (or 12.4 kilometers) deep. And buried **across** the 65,000 producing oil fields in the world, including the 159 oil fields that dotted the 36,000-square-kilometer **Niger Delta** region of southern Nigeria. An oil field is about the size of a town.

## BREAKING THE COMPUTING'S SPEED OF LIGHT

### Fastest Computing to Solve Compute-Intensive Problems

**S**olving the most compute-intensive problems in science and society requires a leap of the imagination. Solving a Grand Challenge Problem of computer science is in a way akin to slaying the fire-breathing dragon of ancient mythologies. Or the super dragon that guards the tree of knowledge.

The research supercomputer scientist needs two swords to slay that dragon. The **first** sword is **intellectual** and is needed for the **theoretical discovery** of fastest computing. The **second** sword is **physical** and is needed for the **experimental discovery** of the world's fastest computing.

### Solving the Nine Philip Emeagwali Equations

An often-asked question is **this**: “Is the system of Philip Emeagwali equations solved?”

The reason my **discovery** of the fastest computing made the **news headlines**, in 1989, was that I went beyond harnessing the total computing power of the **slowest** 65,536 processors in the world. I **visualized** my processors as **evenly distributed** around the surface of a sixteen-dimensional globe that was embedded within a sixteen-dimensional hyperspace.

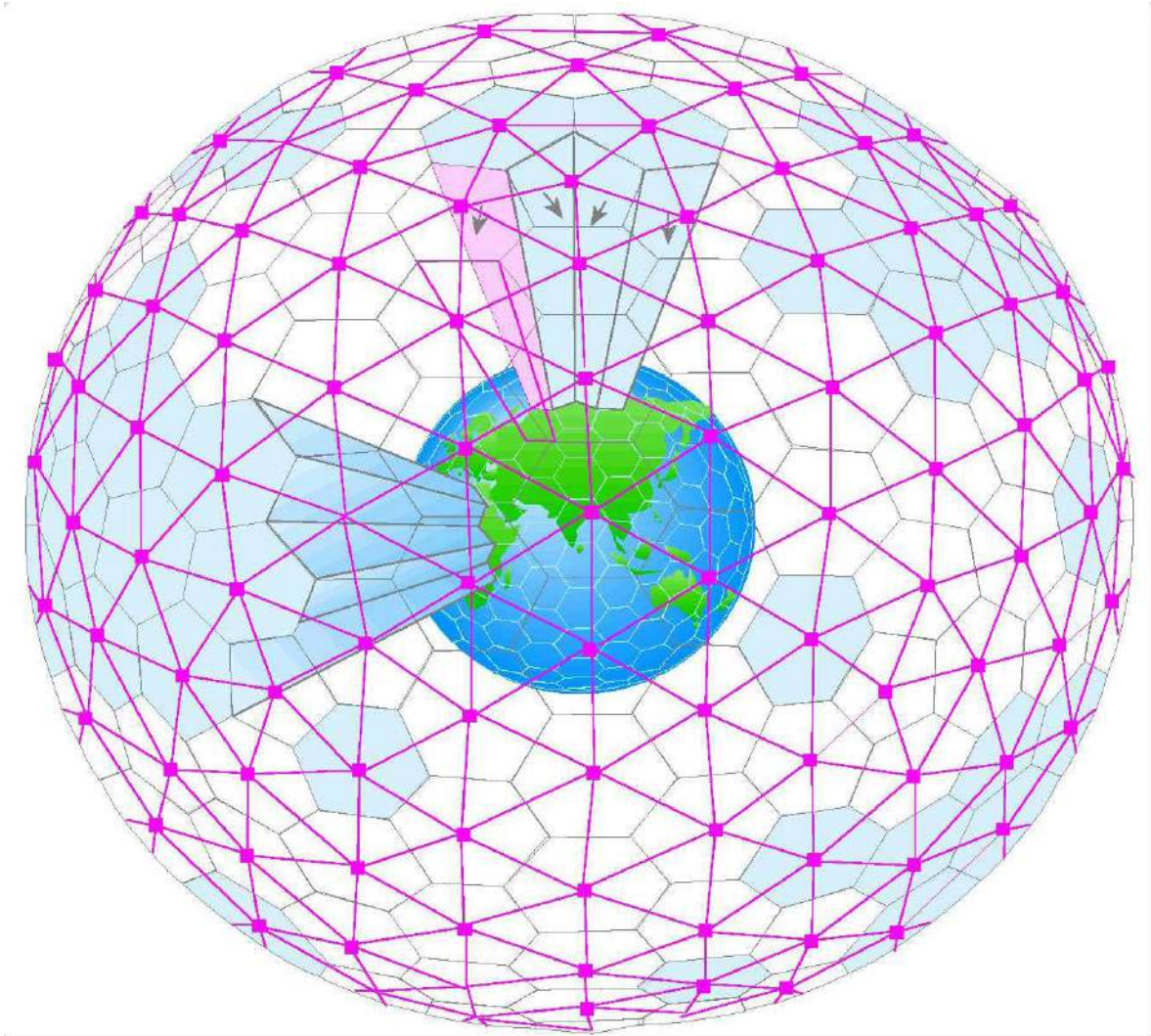
But it took me sixteen years and several stages to **discover** the first world's fastest computing across the world's **slowest** processors. **First**, I **mathematically invented** the correct equations, namely a system of nine coupled, nonlinear, time-dependent, and state-of-the-art **partial differential equations** occurring beyond the frontier of calculus. That **contribution** to mathematics is called the **Philip Emeagwali** equations.

**Second**, I **invented** algebraic algorithms that I used to solve my correct nine **partial differential equations** that encoded the second law of motion described in physics textbooks. The 65,536 processors of my **new Internet** can't be harnessed and used to solve an **incorrect** system of equations of algebra and calculus. And harnessed to solve them **correctly**. Nor can those sixty-four binary thousand processors be harnessed to execute an **inaccurate** algorithm and execute them **accurately**.

Third, I visualized my new Internet as defined in the shape of a square and outlined in the shape of a circle. In three-dimensional space, those shapes become a cube and a sphere, respectively. In sixteen-dimensional hyperspace, those shapes become a hypercube and a hypersphere, respectively.

## VISUALIZING THE PHILIP EMEAGWALI INTERNET

I visualized the Philip Emeagwali Internet in the 16th dimension of space. And visualized my new Internet as a new global network of two-raised-to-power sixteen, or 65,536, identical computers that were defined at the 65,536 vertices of the cube in a sixteen-dimensional hyperspace.



Visualizing the Philip Emeagwali Internet

**Philip Emeagwali Internet Was My Crown Jewel**

Harnessing up to a billion processors to solve the hardest problem and solving it for the first time, on July 4, **1989**, and solving it by executing the world's fastest computing **across** my **new Internet** is the **crown jewel** of my **discoveries in physics and my inventions in computer science**. But the story behind the story is that the technologies are **concrete** and **visible** while the techniques are **profound**, **abstract**, and **invisible**.

The world's fastest computer is up to one billion times faster than your computer. The fastest computer is the heavyweight champion of the computer world. The world's fastest calculation that I **discovered** and **invented across** my **new Internet** was the **crown jewel** that **sparkled in the limelight** and remains **echoic retentive** in the public memory.

### Fastest Computing Across Philip Emeagwali Internet

My **scientific discovery** of the world's fastest calculation received **spontaneous applause**, in **1989**. The supercomputing community **mirrored back** their **appreciative applause** and recognized my **contribution** to computer science by giving me their highest award. Attempting to find my "fastest calculations within a fastest computer" that was powered by a powerful processor was like undertaking to find the **unicorn** that was a **legendary beast with a single, spiraling horn**. The **unicorn** can't be found for the simple reason it does not exist.

My fastest calculations did not exist within **one isolated** super-fast processor that was not a member of an ensemble of processors. My fastest calculations only exist **across** a new Internet. The machinery that I used to record my world's fastest computing only exists as a new Internet that I defined by my 65,536 **equidistant** processors.

My quest for the world's fastest computer was for a **new Internet** that I could use to compute at the **fastest** possible speed. And compute two-**raised-to-power** sixteen times **faster than** the computer. And compute fastest while solving the hardest problems, such as simulating global warming. My **quest** was for human progress that's achieved via an increase in the speed of the computer.

In my **quest** for the world's fastest computer, I followed sixteen **mutually orthogonal**, or **perpendicular**, directions. Those directions led me into an imaginary sixteen-dimensional hyperspace where I **invented** my **new Internet**. And **invented** it as a new global network of 65,536 **equidistant** off-the-shelf processors that were surrounding a globe in that sixteen-dimensional **hyperspace**.

## INVENTING THE FIRST SUPERCOMPUTER

### Solving Compute-Intensive Algebraic Problems

**A**lgebra and calculus are the cornerstones of extreme-scale computational physics. In the 1980s, the most compute-intensive problems arising in large-scale algebra are those from discretized partial differential equations beyond the frontier of calculus and not in any textbook.

The grand challenge in late 20th century calculus was to discover how to parallel process, or how to solve 65,536 compute-intensive problems in algebra or calculus and how to solve them across as many processors. Many articles, including one in the June 20, 1990, issue of *The Wall Street Journal*, credited Philip Emeagwali for inventing how to solve such difficult mathematical problems.

I discovered how to solve the most compute-intensive problems. And solve them across a new global network of 65,536 processors. Those processors were identical, coupled, and shared nothing. They defined and outlined a **new Internet**. I **invented** how to harness that **new Internet** and use its processors to **compute together** and harness up to a billion processors as one coherent, seamless supercomputer that was the **precursor** to the world's fastest computer. I'm the only **father of the Internet** that invented an Internet.

### Fastest Computing Was Once Impossible Across Processors

**The answers to the biggest questions don't come easy.** In a syndicated newspaper article that was **distributed** on September 2, **1985** and **distributed** to the print media and **distributed** by the United Press International, or UPI, and in that article, **John Rollwagen**, the president of Cray Research Incorporated, the company that manufactured **seven in ten** supercomputers, described his company's use of 64 super-fast processors as "**more than we bargained for.**"

### My Invention Opened the Door to the World's Fastest Computer

My **scientific discovery** of the world's fastest computing could be described as follows: A billion processors could be harnessed to compute a billion times faster than one computer. I was in the **news** because I **discovered** the supercomputer solution of the hardest problems **across** an Internet.

My theorized Internet was a global network of a binary billion processors. A **binary billion** is two-**raised**-to-power-**32**, or **4,294,967,296**. My new mathematical solution demands serious ideas and hard work. The reason the twelve-year-old writes an essay on **Philip Emeagwali** is that I **discovered** the world's fastest computing. And discovered how to solve a **billion** problems **simultaneously**, and across an Internet that's outlined and defined by a global network of one billion processors that **shared nothing** with each other.

My discovery made the **news headlines** because it **opened the door** to the world's fastest computer that solves a billion problems **simultaneously**, or in tandem.

## Changing How We Look at the Computer

**Silent** but **powerful protests** followed my **discovery** of the world's fastest computing. My supercomputer **discovery** which occurred on July 4, 1989, was this: I **discovered** a **significant shift** in supercomputing thinking. In the **latest thinking**, the world's fastest computer must harness **one billion** processors. And must use those processors to solve the world's biggest problems that formerly took **one billion** days (or **2.74** million years) to solve and, instead, solve them faster and in only one day.

## World's Fastest Computer

In the search for new knowledge about nature and man-made things, the discovery and invention are the most coveted contributions to science and technology, respectively. For the computer scientist, the most significant progress is made when the world's fastest computer becomes faster.

Each year, the computer gets faster but it's difficult to **articulate** what a specific person **contributed** to develop that year's computer. The **quantum increases** in both the speed and speedup of the world's fastest computer that

I **discovered** at 8:15 on the morning of the Fourth of July 1989, in Los Alamos, New Mexico, USA, is the **quantifiable** and **objective** measure of my **contribution** to the development of the computer. That quantum increase in speed was how I **corrected** the **erroneous** belief that was enshrined into computer science textbooks.

Prior to discovering the world's fastest computing, it was believed that the hardest problems could not be chopped up into a billion less challenging problems. And then solved, in **tandem** and with one-problem to one-processor correspondence, and **across** a billion processors. It was believed that the world's fastest computer, as we know its technology today, will **forever remain** in **science fiction**. A research and development on a **billion-dollar** supercomputer is a financial **contribution** to the world's fastest computer.

Often, the research article is not a contribution to human knowledge. The research becomes a significant **contribution** to computer science, **if and only**, it yielded a new **world's fastest computer** that made the **news headlines** and won the **most coveted prize** in supercomputing, and has other **signifiers** that it's a **significant contribution** that made the world a better place and a more knowledgeable place.

## How I Solved the Most Difficult Problem in Supercomputing

During my first fifteen years of supercomputing that followed June 20, 1974, in Corvallis, Oregon, USA, I identified a **lacuna** in computer science that existed across an ensemble of a billion processors that's wired together as one coherent unit that's an Internet. That missing knowledge was how to harness a billion processors. And use them to solve the most compute-intensive problems in mathematics, science, engineering, and medicine.

I contributed new knowledge, or **scientific discovery**, to the **first** world's fastest computing **across** the world's slowest processors. I did so by **correcting** the imprecise knowledge of supercomputing that was known in computer science textbooks as **Amdahl's law**.

## Correcting Amdahl's Law of Diminishing Supercomputer Speed

In simple terms, **Amdahl's law** stated that fewer than eight processors could be harnessed and used to solve the world's **biggest** problems. I **corrected** that error when I harnessed a new Internet that's a new global



network of 65,536 processors. And used that new Internet to solve one of the most difficult problems, called an initial-boundary value problem of mathematical physics. Such mathematical problems couldn't be solved otherwise, or without using one million processors.

$U_{NEW} = U_{OLD} + \Delta t \Delta S * (C_{SHIFT}(Z, DIM=2) + C_{SHIFT}(CVNORTH, DIM=1, S))$   
 $\Delta t \Delta S * (H - C_{SHIFT}(H, DIM=1, S))$

$$\frac{\partial}{\partial t} U_i + \sum_{j=1}^n U_j \frac{\partial U_i}{\partial x_j}$$

$$= v \Delta U_i - \frac{\partial P}{\partial x_i} + f_i(x, t)$$

$$\text{div } u = \sum_{i=1}^n \frac{\partial u_i}{\partial x_i} = 0$$

$$U(x, 0) = U^0(x) \quad (x \in \mathbb{R}^n, t \geq 0)$$

$$\Delta = \sum_{i=1}^n \frac{\partial^2}{\partial x_i^2}$$

Philip Emeagwali's mathematical statement of the initial-boundary value problem governing fluid flows.

## FASTEST COMPUTING IS MY CONTRIBUTION TO TECHNOLOGY

### Solving Compute-Intensive Problems

The world's fastest computing can't be invented by luck. My invention is the product of a sixteen-year-long quest. During my first decade and half of fastest computing, I analyzed the toughest problems in algebra, calculus, physics, and computer science. And I tried different ways of solving initial-boundary value problems that were governed by a system of partial differential equations at the frontiers of calculus and computational fluid dynamics.

I theorized my parallel-processed solutions both within one processor and across one billion processors. I did both before I discovered that the fastest computing across the slowest processors is not a waste of everybody's time, as was presumed prior to July 4, 1989.

### Fastest Computing is My Signature Contribution to Computer Science

It costs about half a million dollars to train a pre-eminent mathematician. And train her from the first grade to the frontier of mathematical knowledge. But paying half a million dollars to consume the mathematical knowledge that was created by preceding research mathematicians is not a **contribution** to the existing body of mathematical knowledge.

Inventing **new partial differential equations** that occurs at the frontiers of calculus and physics and **inventing** the fastest computing across the slowest processors and using that new knowledge as the tool for solving those difficult mathematical equations were my **two signature contributions** to modern mathematical knowledge.

For those reasons, I was the **cover story** of the top mathematics publication, the May 1990 issue of the *SIAM News* that was the flagship publication of the Society for Industrial and Applied Mathematics. **Mathematics publications featured me to mathematicians not because I was good looking.** I created new mathematical knowledge that no mathematician had understood before.

The *SIAM News* is where recent contributions to mathematical knowledge are published. The *SIAM News* featured me because I **contributed** the nine

Philip Emeagwali equations that were a system of **partial differential equations** at the frontiers of calculus and physics. And I **contributed new** knowledge of how to solve them by supercomputing them **across** millions of processors that **shared nothing** between each other. In 1989, I was in the **news** because I **invented** how to solve initial-boundary value **problems** of mathematical physics. And solve them by supercomputing them across the slowest processors in the world. For that contribution, I won the highest award that computer scientist describe as the Nobel Prize of supercomputing.

## How Are Supercomputers Used in Saudi Arabia?

In an email, a fourteen-year-old writing an essay on famous computer scientists and their contributions to the development of the computer **asked me**: “**How are the contributions of Philip Emeagwali used in Saudi Arabia?**” The supercomputer market is valued at forty-five billion dollars a year. The energy and geoscience industries buy one in ten supercomputers. And use them to **pinpoint** oil deposits.

The **Ghawar** Oil Field of **Saudi Arabia** that was discovered in **1948** had up to **104** billion barrels of recoverable oil reserves. The **Ghawar** Oil Field measures **174** miles by **19** miles. The **Ghawar** Oil Field is declining at eight percent **each year**. Supercomputing across a billion processors is the forty-five billion dollars a year high-performance computing technology that must always be **used** to recover crude oil and natural gas from the **Ghawar** Oil Field. **Saudi Arabia classified** its fastest computer simulations of its oil fields as a **state secret** and proprietary intellectual property.

In 1989, I was in the **news** for **discovering** how the world’s **slowest** processors could be harnessed and used to manufacture the world’s fastest computer. And used to pinpoint the locations of otherwise elusive crude oil and natural gas that were formed up to 541 million years ago. And buried up to **7.7 miles** (or 12.4 kilometers) deep. And buried **across** an oil-producing field that’s the size of a town.

The most important applications of mathematics, physics, and computer science occurs within the world’s fastest computers. The world’s most expensive computer costs one billion, two hundred and fifty million dollars. The world’s most expensive telescope costs ten billion dollars. The world’s fastest computer is to the mathematician what the world’s biggest telescope is to the astronomer.

## DISCUSSION QUESTIONS 1/2

### World's Fastest Computer

1. What is the significance of the invention of the world's fastest computing?
2. How does Philip Emeagwali's unique experience as the inventor of the world's fastest computing contribute to his authority on the subject?
3. What role did Philip Emeagwali's deep knowledge of supercomputing play in his ability to produce lectures and videos without relying on textbook notes?
4. Why is the discovery of the world's fastest computing across the world's slowest processors considered a transformational discovery?
5. How did the invention of a new supercomputer contribute to the development of the new computer science of parallel processing?
6. What are the potential implications and applications of using the world's fastest computing to solve the most pressing problems in science, engineering, and medicine?
7. How did Philip Emeagwali's personal experiences during the period of widespread reprisal attacks in Nigeria influence his journey and contributions to supercomputing?
8. How did the political crisis and assassinations in Nigeria in the 1960s impact Philip Emeagwali's decision to seek safety in Onitsha?
9. What challenges did Philip Emeagwali face during his quest to discover the world's fastest computing across a billion processors?
10. How did Philip Emeagwali's knowledge of physics, calculus, and algebra contribute to his ability to achieve the world's fastest computing?
11. What were the intellectual and physical instruments required to make Philip Emeagwali's mathematical and scientific discoveries?
12. How did Philip Emeagwali's contribution to the development of the world's fastest computing go beyond simply increasing the

speed of computers?

13. Why is mathematics useful in pinpointing the locations of crude oil and natural gas in Nigerian oil fields?
14. How did Philip Emeagwali break the barrier of computing's speed of light to achieve the world's fastest computing?
15. Can you explain the system of Philip Emeagwali equations and its significance in solving the world's fastest computing problem?

## DISCUSSION QUESTIONS 2/2

1. How did Philip Emeagwali visualize the Philip Emeagwali Internet in the 16th dimension of space? What was the significance of this visualization?
2. What is the crown jewel of Philip Emeagwali's discoveries in physics and inventions in computer science? How does it relate to the world's fastest computing?
3. What is the concept of fastest computing across the Philip Emeagwali Internet? How does it differ from computing on a single super-fast processor?
4. How did Philip Emeagwali's discovery challenge the existing belief in Amdahl's Law? What did he do differently in terms of harnessing processors to solve compute-intensive problems?
5. What were the obstacles and challenges Philip Emeagwali faced during his quest to solve the most difficult problem in supercomputing? How did he overcome them?
6. What is the significance of the world's fastest computer becoming faster? How does it contribute to scientific and technological progress?
7. How did Philip Emeagwali's discovery impact the field of computer science? What were the implications for solving complex problems in mathematics, science, engineering, and medicine?
8. How are supercomputers used in industries such as energy and geoscience? What role do they play in pinpointing oil deposits, like in Saudi Arabia?
9. What is the relationship between the world's fastest computer and the field of mathematics? How does it contribute to the advancement of mathematical knowledge?
10. How did Philip Emeagwali's contributions to the development of the computer earn him recognition, including being featured in mathematics publications and winning prestigious awards?
11. Why was it significant for Philip Emeagwali to invent a new Internet and harness the power of multiple processors? What advantages did this approach offer?

12. How did Philip Emeagwali's visualization of processors in a sixteen-dimensional hyperspace contribute to his discovery of the world's fastest computing?
13. What are some of the applications of the world's fastest computers in solving the biggest problems in science, engineering, and medicine? How does it contribute to advancements in these fields?
14. How did Philip Emeagwali's invention of the Philip Emeagwali Internet open the door to the world's fastest computer? What were the implications for solving a billion problems at once?
15. How did Philip Emeagwali's contribution to technology go beyond simply increasing the speed of the world's fastest computer? What additional significance did his discoveries hold?



## 4TH LECTURE: BEYOND THE LIMIT OF COMPUTING



**Broadcast 2 October 2021**

<https://youtu.be/B41TfZBk7M8>

### **Changing How We Look at the Supercomputer**

#### **Year Million Posthuman Computers**

#### **An Internet of Posthuman Gods**

**I**n 1989, I was in the news for providing the “final proof” that supercomputing across the world’s slowest computers is not science fiction. Science deals with facts while fiction deals with truths. Fast computing across 64,000 human computers was first theorized as science fiction, on February 1, 1922. But for seven decades, the idea of fast computing in tandem and across thousands of computers was dismissed for the lack of evidence. In those years, the technology could not be harnessed and used to power the world’s fastest computers.

My **contribution** to computer science that's the subject of schools essays **is this**: I **experimentally confirmed** the **first** world's fastest computing **across** the world's slowest processors. I **discovered** the "**final proof**" that the **slowest processing across** thousands of processors could yield the **fastest computing**. I made that supercomputing discovery sixty-seven years later, on July 4, 1989, in Los Alamos, New Mexico, USA.

Solving the world's biggest problem across a million processors is to the world's fastest computer what playing games with only one processor is to the regular computer. Parallel processing takes computer science into a **new epoch** where millions of processors **work together** to power only one supercomputer.

At 8:15 on the morning of July 4, 1989, in Los Alamos, New Mexico, USA, I became the **first** to stand at the farthest frontier of the world's fastest computer. I was the **first** to gaze out towards unknown territories that were not on the map of computer science. I gazed **across** an ensemble of the world's **slowest** processors to discover the world's fastest computing then unknown to mathematicians and physicists who needed that new knowledge to solve their most difficult problems. That then unknown field of knowledge is where **unexpected** and **unimagined** new computer science, new physics, and new mathematics are almost guaranteed to be discovered.

The world's fastest computing represents a **remarkable confluence** of new ideas from the frontier of mathematics to those of physics and computer science. My **contribution** to computer science **is this**: I was the **first** to synthesize the new **multidisciplinary** ideas. And do so with new ideas of mine. I synthesized ideas to discover that the world's fastest computing **hid** in the **bowels** of an ensemble of the world's **slowest processors**.

It's not only the supercomputer that will benefit from discovering the fastest computing **across** the slowest processors. Our understanding of the supercomputer will increase over the coming years. I believe that the Internet will evolve to become one coherent computer, or a planet-sized supercomputer.

One million years ago, our prehuman ancestors looked like apes. In one million years, or **Year Million**, our posthuman Gods might ridicule our **descendants as looking like humans**. We might have only **living Silicon** as our posthuman Gods that could achieve **immortality**.

In the distant future, **the aliens on Earth could be us**. And the posthuman Gods on distant planets could be our descendants. I envision **posthuman Gods** of Year Million as **thinking across** a Cosmic SuperBrain that is an artificial intelligence. **That human-made genius could sprawl across an epic landscape to become** their eighth supercontinent. That powerful brain could enshroud our seven land continents and enshroud the Earth with their Year Million electronic wires.

I foresee our descendants being part-humans and part thinking machines. The grandchildren of our grandchildren may not use their Internet how we use our Internet. **Their Internet could be within them while our Internet is**

around us. Posthuman Gods will not need supercomputers because they could **be** infinitely fast computing machineries.

## PHILIP EMEAGWALI INTERNET



father of the internet

**philip emeagwali** father of the internet  
**tim berners lee** father of the internet  
**vint cerf** father of the internet  
**dr philip emeagwali** father of the internet  
**leonard kleinrock** father of the internet  
**nigerian** father of the internet  
**bob kahn** father of the internet  
**npr** father of the internet  
**african** father of the internet  
father of the internet **al gore**

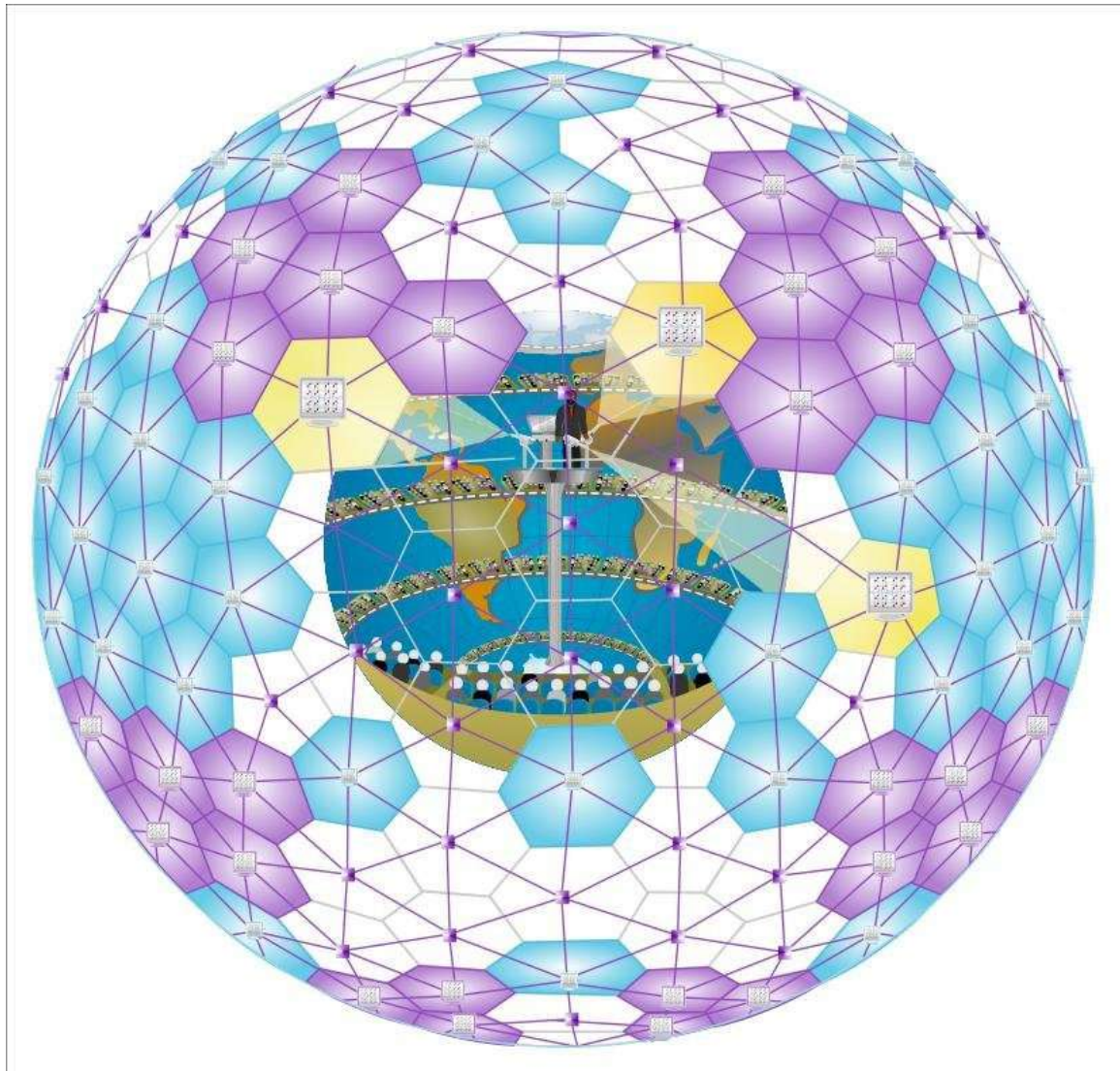
Google ranks Philip Emeagwali as the [father of the Internet](#) (Labor Day 2019).

**I**n 1989, it made the news headlines that I—Philip Emeagwali—had experimentally discovered how to solve some of the most compute-intensive problems in mathematics and physics. I was cover stories because I discovered how to solve the most difficult problems in mathematics and physics. And solve them with the world's fastest computer that was powered with the world's slowest processors.

Furthermore, I **invented** how to solve the hardest problems, called extreme-scale computational fluid dynamics. Likewise, I **invented** how to solve difficult mathematical problems **across** a **new Internet** that's a new global network of up to one billion **coupled processors**. **Each processor**

operated its operating system and shared nothing. I was in the news because I invented a new Internet that's a new global network of millions, or billions, of processors.

I invented how to parallel process or how to execute a **billion** set of computer instructions. And how to execute them **simultaneously** or how to execute them in parallel and **across a billion processors**. My invention of how the world's **fastest** computer can be built from the **slowest** processors enables the supercomputer to compute a **billion** times **faster** than the regular computer.



The earliest blueprint for the Philip Emeagwali supercomputer that's Internet that was conceived in 1974, in Corvallis, Oregon. Philip Emeagwali is the only father of the Internet that invented an Internet.

### My Earliest Years in Computing

I began my quest for that **new Internet** in **1974** in Oregon, USA. I began as a janitor-mathematician who put away his **slide rule**, that was also called an analog computer, that he bought in **1970** and brought from Onitsha, **Nigeria**. In late 1970, it seemed like I was the only person with a slide rule in Onitsha (**Nigeria**). I also put away my **log table**, that was my only **computing aid**, of **1967** at our home that was the Nurses' Quarters of General Hospital, Agbor, **Nigeria**. I put away both my slide rule and log

table to learn how to compute fastest and do so when solving compute-intensive systems of equations in algebra.

## Inventing the Nine Philip Emeagwali Equations

In **1974**, in Corvallis, Oregon, **USA**, I learned how to use the fastest computers to solve those equations arising in computational linear algebra. They were **impossible** to solve on the blackboard, or solve with pencil and paper. I learned how to solve a huge system of equations of modern algebra and solve them on a supercomputer that was powered by only one electronic brain.

As a research mathematical physicist who came of age in the **1970s** and **80s**, I understood how those difficult mathematical problems arose from some laws of physics. I understood how the new calculus were derived. And how those laws of physics were **encoded** into the system of **partial differential equations** beyond the frontier of calculus. They are called the nine **Philip Emeagwali** equations.

## My Earliest Years of Computing in the USA

I made my debut as a computational mathematician on one of the world's fastest computers. I began supercomputing because I needed to solve a huge system of equations in algebra. I began my supercomputer quest on Thursday, June 20, **1974**, in Monmouth, Oregon, in the Pacific Northwest region of the **United States**. I entered my programs into a **time-shared** supercomputer that was at 1800 SW Campus Way, Corvallis, Oregon.

I submitted my executable programs that were written in high-level programming languages, such as **BASIC** and **FORTRAN**. And entered them through my **remote job entry terminal**. **BASIC** is the **acronym** for Beginners' All-purpose Symbolic Instruction Code. It's a general-purpose, high-level programming language. **FORTRAN** is the acronym for **FORmula TRANslation**. It's the first choice, programming language of engineers and mathematicians and other creators of scientific algorithms. My knowledge of supercomputers grew over the decade and a half that followed June 20, **1974**.

## OVERCAMING RACIAL BARRIERS IN SCIENCE

### My Supercomputer Access Was Denied

**I**n the 1970s and 80s and as a Black and African-born, in the USA, conducting a decade-and-half long multidisciplinary research in computational physics, I was effectively banned from using supercomputers.

For that reason, I couldn't conduct research on vector supercomputers that costs about forty million dollars each, in the early 1980s. My accesses to the fastest vector supercomputers were revoked, after they discovered that I was Black and African-born. It was **revoked** at various institutions, such as the U.S. National Weather Service, Camp Springs, Maryland. And **revoked** from [the University of Michigan], Ann Arbor, Michigan, for the supercomputer center in San Diego, California, that was operated by the U.S. National Science Foundation.

### My Supercomputing Job Offers That Were Rescinded

In July 1985, I was tentatively offered a job, as a supercomputer scientist, at the **Great Lakes Environmental Research Laboratories** of the U.S. **National Oceanic and Atmospheric Administration**, in **Ann Arbor**, Michigan. For practical purposes, I was offered the job via telephone, when they **presumed** that I was **white**. Two months later, on about September 24, 1985, I was flown into **Ann Arbor**, Michigan, to give my supercomputer hiring research lecture and do so in the lecture auditorium of the Great Lakes Environmental Research Laboratories, in Ann Arbor, Michigan. When the decision makers knew that I was Black and African, they decided **not to hire me** as their supercomputer scientist.

Fast-forward four and a half years, after that **rejection**, newspapers in **Ann Arbor**, Michigan, were writing stories about an African supercomputer genius, named **Philip Emeagwali**. I was in the news because I had won the **highest award** for my **contribution** to supercomputing. At the Great Lakes Environmental Research Laboratories, the white supremacists were **shocked** to learn that the Black supercomputer scientist that they interviewed but **rejected**, four and a half years earlier, is in the news for **inventing** the **first** supercomputing **across** the world's slowest **computers**.



## Sabotages of My Supercomputing

In 1989, I was in the news for the discovery of fastest computing. That was a scientific discovery that I was supposed to have made at the [Great Lakes Environmental Research Laboratories](#). Because I was Black and African, I wasn't [permitted](#) to make my supercomputer discovery in **Ann Arbor**, Michigan.

As an aside, a search through the [eight billion](#) videos that were posted on YouTube will reveal that nobody in [the University of Michigan], Ann Arbor, Michigan, or anywhere else in the world, then and now, had or has the commanding combinations and grasp of mathematics, physics, and computer science that was needed to contribute the new knowledge that will enable the fastest computing across the slowest processors as well as deliver lectures on their contributions to supercomputing that is [on par](#) with the one thousand closed-captioned videos that I posted on my YouTube channel named "[Emeagwali](#)." This gap in scientific knowledge was widely written about within [the University of Michigan], Ann Arbor, Michigan, and beyond.

Research scientists in [the University of Michigan], Ann Arbor, Michigan, revered my discovery of the world's fastest computing. Their reverence was documented in a special issue on **Philip Emeagwali** in their flagship publication, called *The Michigan Today*. That February 1991 issue of *The Michigan Today* was titled: "[One of the World's Fastest Humans](#)."

The *Michigan Today* is a quarterly publication that's mailed to 610,000 alumni [of the University of Michigan]. The PDF version of that February 1991 issue, on **Philip Emeagwali**, can be searched for and read online. As an aside, that *Michigan Today* issue on **Philip Emeagwali** was used to develop two nation-wide law school admission tests.

In September 2009, the **LSAT** (or Law School Admission Test) of the [USA](#), had a reading comprehension section that focused on "**Philip Emeagwali**" and that drew from that *Michigan Today* issue of February 1991. And in December 2009, the same American Law School Admission Test also focused on my contributions to computer science and drew from that *Michigan Today* issue of February 1991. That reading comprehension section of the American **LSAT** as well as millions of school essays on **Philip Emeagwali** put me on the same platform with **Albert Einstein** and **William Shakespeare**.

Giving that level of recognition to a young Black sub-Saharan African will always incur extreme jealousies from white supremacists who argue that **Albert Einstein** has a higher IQ than **Philip Emeagwali**. In [the University of Michigan], Ann Arbor, Michigan, of 1989, many white supremacists were sad and jealous of all the fame and attention that I was getting. The jealous ones among them had the shaky feeling that they could win that Nobel Prize of supercomputing and do so if they had access to a

supercomputer. They had access to supercomputers, since 1946. But they lacked the scientific knowledge that I possessed and exhibited in my one thousand podcasts and YouTube videos.

So, I was **rejected** on September 24, 1985, in Ann Arbor, Michigan, solely because I was Black and sub-Saharan African, not because I lacked the intellect and knowledge. I was the **first** to discover the world's fastest computing, as it's known today.

By the early **1980s**, I was ahead in the supercomputer race for the **fastest** calculation in the world that could be executed **across** the **slowest** processors in the world. But as a Black supercomputer scientist who worked alone, I was perceived as a **threat** instead of welcomed as a contributor to supercomputing. In the early to mid-1980s, I was **blacklisted** and **denied access** to vector supercomputers that were then the fastest in the world. I was forced to back off just before I could make a supercomputer breakthrough.

## How I Won the Top Award of Supercomputing

In **1989**, it made the **news headlines** that an African supercomputer genius who worked alone had won the highest award in supercomputing. And won it for **inventing** how to solve 65,536 difficult mathematical problems in large-scale computational fluid dynamics.

At its compute-intensive core, each mathematical problem was a system of **366** equations of computational linear algebra. I solved each system on the slowest processor in the world. I totaled those problems **across** my ensemble of 65,536 processors. Each processor was coupled to its sixteen closest-neighboring processors. Each processor **shared nothing** with its nearest-neighboring processors.

In the news articles, I was described as the African supercomputer inventor who **invented** how to solve those world-record algebraic equations. And solve them **across** a new Internet that's a new global network of 65,536 off-the-shelf processors that were identical to each other.

## INVENTING THE FIRST SUPERCOMPUTER

I was the Internet scientist in the news in 1989. My scientific discovery of the fastest computing across a new Internet that's outlined by up to one billion processors occurred on the Fourth of July 1989. My invention was mentioned in the June 20, 1990, issue of The Wall Street Journal.

That was my **contribution** to mathematics. That **contribution** has diverse everyday applications in science and engineering, such as weather forecasting. That scientific discovery was my **Eureka invention** as a new Internet **scientist**. It was my **Eureka moment** because I discovered **two new Internets**. I theorized my **first Internet** in **1974**.

My **first Internet** was the supercomputer technology which I **constructively reduced to practice** as my **second Internet** that was comprised of my new global network of the 65,536 **slowest** processors in the world. I programmed them, in 1989, to execute the **fastest** computations in the world. And execute them while solving the most **difficult** problems that arise in mathematics and physics.

My **first Internet** was **unknown** in the computer textbooks that were published in **1974**. That was the year I made my debut in supercomputing at 1800 SW Campus Way, Corvallis, Oregon, USA. My **second Internet** was **unknown**, in 1989, the year I recorded the fastest computer speed. And recorded it in Los Alamos, New Mexico, USA.

### Inventing the First Supercomputer

#### Fastest Computing Across a New Internet

My **invention** of how to solve up to a billion difficult mathematical problems **simultaneously** and solve them with a **one-problem** to **one-processor** correspondence and solve them **across** a **new Internet** is the reason for writing school essays titled: "The Contributions of **Philip Emeagwali** to the Development of the Computer."

Because I wasn't allowed to conduct my scientific research and do so in conventional vector supercomputing, I was forced to **change direction**. And conduct my research on how to harness the 65,536 **slowest processors** in the world. And how to use those processors to invent a **new supercomputer that is beyond super**.

The life lesson that I learned from those rejections **was this**: **When one door closes, another door opens**. When the door that led to the room that was housing the conventional vector supercomputer **closed**, the door that led to the building housing the most powerful supercomputer also **opened**.

## How I Leapfrogged to the World's Fastest Computer

### Supercomputing Subterranean Fluid Dynamics

I'm a **Nigerian**-born large-scale computational fluid dynamics engineer who came of age in the USA and in the 1970s and 80s. My testbed supercomputing problems for my ensemble of **64** binary thousand processors ranged from global atmospheric flows to the **fluid dynamics** within an oil-producing field that's up to **7.7 miles** (or 12.4 kilometers) deep and that covers an area that's often the size of Mogadishu (**Somalia**). As a computational physicist, my supreme quest is to match physics models and simulations to the actual **geophysical fluid dynamics** being simulated.

## Inventing the Shape of the World's Fastest Computer

One of the most difficult mathematical problems is global climate modeling. It has an associated initial-boundary value problem that's formulated at the **crossroad** where modern calculus, computational physics, and fastest computing intersect. That compute-intensive problem is mathematically defined over a physical domain.

For my global climate models, I visualized the geometrical shape of the global warming problem as a globe that has a diameter of 7,900 miles. That globe was **enshrouded** by a **concentric** sphere that has an inner diameter of 7,900 miles and an outer diameter of 7,962 miles. The inner diameter of that globe was my **geometrical metaphor** for the surface of the Earth. The outer diameter of that globe represents the **limits** of the atmosphere of the Earth.

## Breaking the Barriers of Computing

My **contributions** to the invention of the first world's fastest computer, as it's known today, **were these**: At 8:15 on the morning of the Fourth of July 1989 in Los Alamos, New Mexico, **USA**, I **jumped in joy** because I **discovered** the fastest computing **across** the **slowest** processors. I **invented** the technology as the **new world's fastest computer** that's defined **across** the **slowest processors** in the world.

That **new** supercomputer that made the **news headlines** wasn't a computer, by or in itself. I visualized my **new supercomputer** as my **new Internet, in reality**. That new Internet was a **new** global network of off-the-shelf processors that were parallel processing as one seamless, coherent, and gigantic supercomputer. And computing together to solve the world's most important and complex challenges.

## INVENTING THE PHILIP EMEAGWALI INTERNET

I first discovered the first world's fastest computing across my theorized Internet that's a new global network of sixty-four binary thousand, or two-raised-to-power sixteen, processors. My processors were identical and shared nothing. I visualized and theorized my 65,536 processors as identical computers that were evenly distributed around the Earth. I visualized those two-raised-to-power sixteen identical computers as being equal distances apart. And with much uniformity in processors and regularity in email wires.

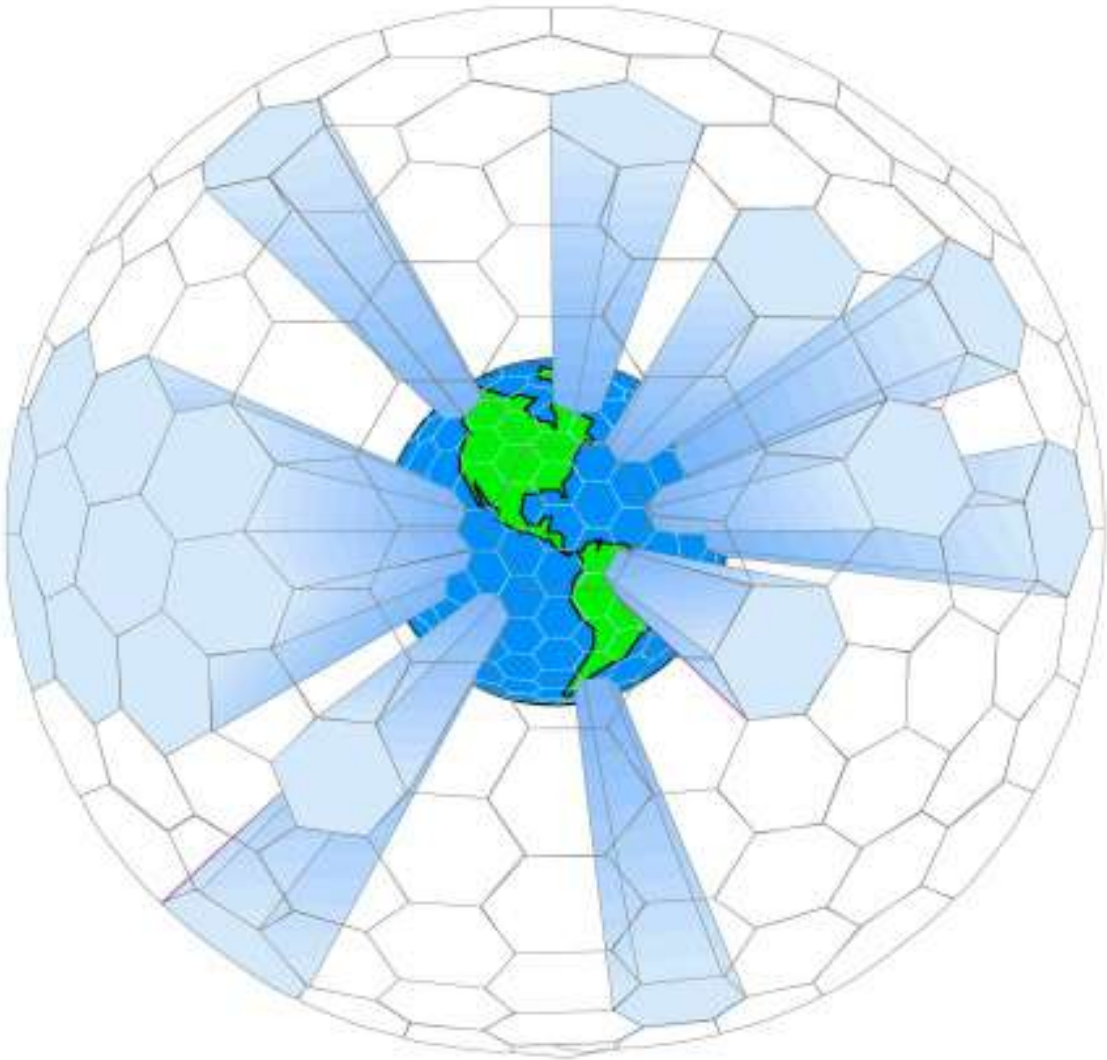
Over the fifteen years that followed June 20, 1974, in Corvallis, Oregon, USA, my [theorized Internet](#) evolved towards a new global network of sixty-four binary thousand processors that I [visualized](#) as encircling a ball in my sixteen-dimensional hyperspace. I called that ball a [HyperBall](#). Years later, that name, HyperBall, was replaced by the current name "[Emeagwali Computer](#)." I visualized the [Emeagwali Computer](#) as shaped like a hypercube that's tightly circumscribed by a HyperBall.

### Fastest Computing at a Crossroad

The world's fastest computing resides at the crossroad where new calculus, the most large-scaled computational physics, and the fastest computing [intersect](#). Because fastest computing [across](#) a billion processors is a highly [multidisciplinary](#) field of study, it's problematic to explain where the mathematics [ended](#) and where the physics [began](#) and where the computer science [continued](#). As a supercomputer scientist who [came of age](#) in the 1980s, I've been identified as a mathematician or a physicist or a computer scientist.

In the 1970s and 80s, fastest computing [across](#) the [slowest](#) processors was very [complicated](#) and was [mocked](#) and [ridiculed](#) as science-fiction and as a tremendous [waste](#) of everybody's time. In the 1980s, I was the only full-time programmer of the most massively parallel supercomputer [ever built](#). That supercomputer was powered by 65,536 processors.

[Today, the world's fastest computer is programmed by up to ten thousand mathematicians and scientists](#). The reason I programmed such machinery alone, in the 1980s, was that nobody else understood how to execute the fastest computing. And do so [across](#) the [slowest](#) processors. And record supercomputing speeds that's a million times faster than a computer that's powered by only one processor.



The earliest blueprint for the Philip Emeagwali supercomputer that's Internet that was conceived in 1974, in Corvallis, Oregon.

## CHANGING HOW WE LOOK AT THE COMPUTER

**M**y contributions to computer science were these: I discovered how to harness millions of processors and use them to reduce the wall-clock time-to-solution. And reduce that time from 30,000 years within one processor to one day across a new Internet that's a new global network of 10.65 million off-the-shelf processors.

My supercomputer **invention** occurred on July 4, 1989, in Los Alamos, New Mexico, **USA**. My **invention** of the **first** supercomputing **across** the world's slowest computers that outline an Internet made the **news headlines** because it **indicated progress** in computer science. And resulted in a **fundamental change** that **changed how** we will look at the regular computers of **tomorrow** that could evolve from the fastest computers of **today**.

The world's fastest computer speed that I **discovered** and that made the **news headlines was this**: The processing power of the world's fastest computer which now occupies the space of a soccer field can be **increased** to the power of a theorized supercomputer that could **enshroud** the Earth in **forthcoming centuries**. The world's fastest computer can weigh more than a million pounds, or eight thousand persons.

The supercomputer of the future could be powered by **trillions** of processors that will be communicating as an Internet that enshrouds the Earth. That planet-sized computer could enable discoveries **across** science and industry.

### Fastest Computing is a Billion Times Faster than Computing

#### Simulating Nuclear Explosions

In the **1980s**, I couldn't conduct my research on how to harness one million processors. And use them to solve the hardest problems in science, engineering, and medicine. As a supercomputer scientist, I came of age in the **1970s** and **80s** and in the **USA**. In those two decades, it was **impossible** for a Black African-born but naturalized U.S. citizen, such as myself, to gain the **top-secret clearance** that was needed to work with the world's most powerful supercomputers. The fastest computers are used to **simulate the explosions** from **detonating** nuclear bombs.



## Black Inventors Were Not Hired

The U.S. national laboratories—not universities and corporations—were the primary places that I could conduct my research in fastest computing **across** the **slowest** processors. In the **1980s**, I had the **visceral feelings** that I was on a hot track to **discover** and **invent** how and why a million processors that computed in tandem could be harnessed to make **future** computers faster and supercomputers **fastest**.

In retrospect, I was pursuing a supercomputer **invention**—namely parallel computing—that couldn't be **invented** under the vision of any U.S. national laboratory. Or be **invented** as part of a supercomputing research team anywhere in academia. That, plus the fact that I was Black and African, was the reason I wasn't hired as a research supercomputer scientist in the **1970s** and **80s**.

## Father of the Internet | A Beautiful Theory that is an Internet

In my **unsuccessful** hiring talks that I delivered in U.S. government laboratories, I provided **broad brushstrokes** to research computational physicists. And to research computational mathematicians. Back then, my theories on how to solve the hardest problems and solve them **across** a million processors were **dismissed** as **science fiction**.

My idea was ridiculed as a **beautiful theory** that lacked experimental confirmation. That beautiful theory was my **new Internet** that I visualized as a new global network of 65,536 off-the-shelf processors that **shared nothing, but were in dialogue with each other**. My **broad brushstroke** was to solve the most difficult **problems** in mathematics, science, and engineering. My supercomputing quest was to discover how to solve them **across** my ensemble of two-raised-to-power sixteen processors that were coupled to each other.

In the **1970s** and **80s**, the world's fastest computer speed that I recorded on July 4, 1989, was **mocked** as a huge embarrassing mistake. And dismissed as science fiction. Achieving the fastest computing **across** the slowest processors was ridiculed as an **empty pipe dream**.

## MY LEAPFROG FROM COMPUTER TO INTERNET

In 1974, and in Corvallis, Oregon, I made a leap of my imagination. I leapt from a theorized global network of sixty-four thousand human computers that were equal distances apart, and around the Earth, to my theorized global network of sixty-four binary thousand computers that were also uniformly distributed around the Earth. I made that leap of my imagination because that's what humans do. Humans extrapolate from the known to the unknown. The genius is the ordinary person that found the extraordinary in the ordinary.

### Why is Supercomputing a State Secret?

The need for faster computers isn't going anywhere. The supercomputer will help define the **political** and **economic** powers of the 21<sup>st</sup> century. The nation that controls the technology that powers the world's fastest computer controls high-stake **seismic imaging** and petroleum reservoir simulation. Both technologies must be used to nail down the exact locations of crude oil and natural gas that were formed up to **541 million** years ago.

The nations that control petroleum technologies control the 65,000 oil fields in the world. This is the reason **China** wants to control the technology that powers the world's fastest computers. Doing so will enable China to take the first step in controlling some of the 159 producing oil fields in **Nigeria**.

Therefore, it will not come as a surprise that the **Saudi Arabian** government placed **armed guards** around its most powerful supercomputer. One of the world's fastest computers is used to simulate the recovery of crude oil and natural gas from the vast oil fields of **Saudi Arabia**. **Saudi Arabia** classified the supercomputer simulations of their oil fields as **state secrets**. They're **state secrets** because the supercomputer is the key to the **petroleum dependent** economy of **Saudi Arabia**.

The supercomputer is the **magical lock** that, so to speak, opens the oil field that's buried up to **7.7 miles** (or 12.4 kilometers) deep in the **Sakhalin** Island in Russia's Far East. And up to twice the size of the state of Anambra, Nigeria.

## The Size of the Supercomputer Market

The world's fastest computer is not only the **pinnacle** of the computer industry, but it's also **big business**. In recent years, the industry grossed forty-five billion dollars a year.

## AN INTERNET THAT'S ALSO A SUPERCOMPUTER

### Inventing the Supercomputer as an Internet

I'm the only father of the Internet that invented an Internet. The first Internet that I invented was a new global network of processors. I designed that Internet to be congruent with the atmosphere of the Earth. I reasoned that the surface of the Earth is enshrouded by a 62-mile-deep ocean of air, moisture, and water, such as the rivers, lakes, oceans, and even fluids like crude oil and natural gas. Furthermore, I visualized that 62-mile deep body of fluid as a concentric sphere with an inner diameter of 7,917.5 miles (or 12,742 kilometers).

Not only that, I visualized that concentric sphere as tessellated into 65,536 equal-sized ocean of fluids that extended from the bottom of the oceans to the uppermost boundary of the Earth's atmosphere. I had to visualize the shape of my new Internet as follows: My new Internet must circumscribe a globe has a diameter of 7,917.5 miles (or 12,742 kilometers).

I defined my new Internet as outlined as a new global network of 65,536 processors that has a one-to-one correspondence with 65,536 equal-sized physical domains. Each processor within my new Internet will run one climate model. The world's fastest computer occupies the footprint of a football field. And internally communicates across a total of 200 miles, or about 322 kilometers, of cables. And it costs one billion, two hundred and fifty million dollars each. That world's fastest computer is the top dog in mathematics.

Where is the measurable paradigm shift, or the step-changing discovery, that's the greatest milestone in the history of the computer? Where is the continental drift of supercomputing? The increase in the speed of the supercomputer is the central essence of what defines progress in computing. The world's fastest computer could become the laptop computer of tomorrow.

Speed is the essence of the computer. Therefore, a paradigm shift, or a change in how we think about the computer, occurs when there's a quantum leap in supercomputer speeds. According to Moore's law, the speed of the computer is expected to double every eighteen months. However, that factor-of-two increase in computer speed is merely evolutionary and conventional. That factor-of-two increase wasn't a paradigm shifting discovery. Visualization was the key instrument which I used to invent my new Internet that's a new global network of off-the-shelf processors which defined and outlined my new supercomputer.

I used the cube as my metaphor for my new Internet. And I visualized a processor as corresponding to a vertex of the cube. And a bidirectional

email wire as corresponding to each edge of the cube. Furthermore, I visualized my **new Internet** as a cube that was tightly circumscribed by a sphere.

For my world's fastest computing emails that made the **news headlines**, in 1989, I visualized my cube as a **hypercube** in the 16<sup>th</sup> dimension that was circumscribed by a **hypersphere** in the 16<sup>th</sup> dimension. I visualized my **new Internet** as defined and outlined by a new global network of sixteen **times two-raised-to-power sixteen**, email wires. Or a network of one binary million, or **1,048,576**, bidirectional edges of that **hypercube**. I visualized my email wires as projected and as **etched onto** the fifteen-dimensional **hypersurface** of that sixteen-dimensional **hypersphere** that "**circumscribed**" it.

Finally, I visualized those edges as my metaphors for my **1,048,576** bidirectional email pathways that **emanated** to and from my new global network of 65,536 off-the-shelf processors that was my **new Internet**. I visualized my processors as equal distances **apart** and as corresponding to the as many vertices of the **hypercube** on that **hypersurface**. **For these contributions, I'm the only father of the Internet that invented an Internet.**

## A QUANTUM LEAP IN SUPERCOMPUTER SPEED

**A**t 8:15 on the morning of July 4, 1989, in Los Alamos, New Mexico, USA, I discovered how to increase the speed of the fastest computer and do so by a factor of 65,536. I recorded my computer speedup across as many processors. On that day, I also discovered how to, in theory, increase that speed by a factor of one billion across one billion processors. I visualized those one billion processors as uniformly encircling a globe and doing so as a new Internet. That new Internet was where I executed the world's fastest computing.

For six months after my discovery of fastest computing, leading supercomputer scientists were shocked at the speed of my calculations. But some supercomputer scientists mocked my discovery of the alternative way of executing the world's fastest computing. And using that new knowledge to solve the most difficult problems arising in mathematics.

The naysayers wrote that Philip Emeagwali has made a "terrible mistake." Those naysayers stopped laughing at me after it was announced that my discovery of the world's fastest computing has been validated. I won the highest award in supercomputing and for 1989.

My discovery of fastest computing made the news headlines around the world and became my signature invention. It's the reason Philip Emeagwali is the subject of school essays. Achieving that 65,536-fold increase in supercomputer speed was a fundamental change of tectonic proportions that changed how we look at the world's fastest computer. Computing across up to a billion processors was a magical change because it was both unexpected and extraordinary. The reason my scientific discovery of the world's fastest computing made the news headlines was that the new technology was both unorthodox and revolutionary.

### Unlocking the Power of the Supercomputer to Foresee the Otherwise Unforeseeable

In the **conventional paradigm** of supercomputing, called serial computing, the computer scientist **visualized** one processor as computing **automatically** to solve one of the most difficult problems in mathematics. One such problem was the initial-boundary value problem arising at the frontier of calculus and large-scale computational physics. The system of **partial differential equations** that governs such initial-boundary value problems is at the mathematical and computational core of the highest-

resolution global climate model that must be used to foresee otherwise unforeseeable long-term global warming.

## My Leapfrog from Slowest Computing to Fastest Computing

What separates the old and new ways of fastest computing is not the problem they solve but how they solved it. In their old way, mathematical problems are solved within one processor. In my new way, they're solved **across** up to one billion **coupled processors**. Those processors **emulate** one seamless, coherent, and gigantic supercomputer. **The Internet is the precursor to a planet-sized computer** that will shine like a beautiful star in a dark galaxy.

## AN IMAGINARY ODYSSEY

### Picturing a World Without Computational Fluid Dynamics

Esteemed members of the Award Committee, revered scholars, distinguished guests, and dear friends from the global community, with humility and honor, I address you as Philip Emeagwali.

In 1989, the world bore witness to an unprecedented computational marvel. As an African computational scientist, my discovery of the first supercomputing, via parallel processing, entered the global spotlight when I forged a pathway to solve the most gargantuan system of equations, pivotal to computational fluid dynamics (CFD). In 1989, I was in the news for making a groundbreaking contribution to physics, namely, extending the map of computational physics to include parallel supercomputing.

On this auspicious occasion, I invite you to traverse with me through the intellectual corridors of imagination, to envision a reality without the foundational and transformative discipline of computational fluid dynamics.

Computational fluid dynamics is not a mere amalgamation of lofty terms but is the crystallization of human curiosity and intellect regarding the movement of fluids, the invisible yet potent forces that sculpt the physical and natural world, from the swirling galaxies far above to the coursing blood in our veins.

In the absence of computational fluid dynamics, we would dwell in a world markedly opaque, where the eloquent dance of air currents and water flows remain obscured, a poetic but unintelligible dialogue between nature's elements and humanity's quest for understanding.

Without the tools and insights furnished by CFD, our ability to predict and navigate the atmospheric dynamics that cradle our airplanes and the aquatic tapestry that buoy our ships would be precariously tethered to empirical observation, bereft of the precision and foresight that define modern aeronautical and naval engineering.

CFD is the silent and diligent cartographer of the invisible territories of fluid motion, illuminating the pathways of gas and liquid, offering invaluable insights into the dynamics of weather and climate, the mechanisms of industrial processes, and the myriad phenomena that are the lifeblood of ecosystems and the environment.

In a world devoid of CFD, the bridges that span our mighty rivers, the skyscrapers that kiss the clouds, and the vehicles that traverse land, sea, and sky would be conceived without the intimate understanding of the forces that caress, buffet, and challenge their existence. The edifices of human ingenuity would stand, but perhaps less confidently, less securely,



with their invisible interaction with the fluid environment remaining a chapter unread, a dialogue unheard.

In the fields of medicine and biology, the absence of CFD would veil the microscopic highways of blood flow and the molecular dance of respiratory gases, rendering the landscape of life's fluids a beautiful but cryptic mural, appreciated but not fully comprehended.

Yet, let us recognize that the tapestry of computational fluid dynamics, while magnificent, is also a canvas that requires the careful and ethical brushstrokes of its practitioners. With the knowledge and power conferred by CFD, comes the solemn responsibility to employ its insights for the betterment of humanity, the protection of our precious environment, and the advancement of the collective human endeavor.

As we contemplate a reality without computational fluid dynamics, let us also reaffirm our commitment to harnessing its capabilities with wisdom, integrity, and a vision that transcends the immediate horizon, reaching into the future with hope, aspiration, and a resolute dedication to learning, discovery, and enlightenment.

Dear colleagues and friends, I extend my deepest gratitude for your presence and attention. Together, let us continue to explore, understand, and celebrate the wondrous and intricate dance of fluids, guided by the compass of computational fluid dynamics, towards a future that reflects the best of science, technology, and the human spirit.

Thank you.

## WHEN THE SKIES FALL SILENT

### The Hypothetical Absence of Weather Forecast Models

Honored members of the Award Committee, cherished colleagues, respected academics, and distinguished guests from the four corners of our beloved Earth, I extend my warm greetings to you as Philip Emeagwali.

I am here because—on July 4, 1989, in Los Alamos, New Mexico—I became the first to discover the world's fastest computing across multiple processors. That was proof that I went further than any had before. For that contribution, I was awarded what was described as the Nobel Prize of supercomputing, in 1989.

Today, let us engage our minds in an exercise of contemplation, stepping into a realm of imagination where the sophisticated and indispensable tools of weather forecast models do not grace our intellectual horizons.

Weather forecast models are not just intricate configurations of algorithms and computations; they are the silent, vigilant sentinels standing guard over humanity's interaction with the ceaseless ebb and flow of the atmospheric tides. These models are the translators of the cryptic language of the skies, whispering to us the secrets of impending storms, the soft lull of fair weather, or the tumultuous dance of hurricanes.

Imagine, dear friends, a world where these models are absent. Without these vigilant guardians, our societies would stand exposed to the whimsical and often ferocious elements of weather, with the cloak of prediction and preparedness stripped away, leaving us vulnerable and blind to the meteorological dynamics unfolding above.

In a world bereft of weather forecast models, the tapestry of daily life, agriculture, commerce, and aviation would be draped with the fog of uncertainty. Farmers, the stalwart nourishers of humanity, would sow their seeds and tend their fields under the shadow of unpredictability, with the rains and sunshine arriving unannounced and often with disconcerting inconsistency.

Aviation, that marvelous testament to human ingenuity, would navigate the skies with heightened risk and trepidation, with pilots deprived of the crucial foresight provided by accurate weather forecasts. The intricate dance of global commerce and trade would similarly falter and stumble, as the seas and oceans reveal their moods without warning, tossing ships and their precious cargo at the mercy of untamed waves and winds.

Yet, as we consider this scenario, let us also reflect on the responsibility that accompanies the invaluable gift of weather forecast models. With the

power to predict and prepare comes the duty to respond and protect, to leverage this foresight not just for economic gain but for the safeguarding of lives, livelihoods, and the delicate ecological tapestry that sustains all life on Earth.

In envisaging a world without weather forecast models, let us acknowledge and appreciate their unparalleled contributions and commit ourselves to wielding these tools with wisdom, empathy, and a steadfast dedication to the well-being of all inhabitants of our shared planet.

I extend my heartfelt gratitude for your presence and participation in this symposium of imagination and reflection. With the watchful eyes of weather forecast models and the collective commitment of this esteemed community, let us continue to chart a course through the skies of challenge and opportunity, towards a horizon bright with understanding, preparedness, and care for one another.

Thank you.

## GAZING INTO THE CLIMATE CRYSTAL BALL

### The Power of General Circulation Models

Esteemed members of the Award Committee, respected academics, valued guests, and dear colleagues from all corners of our shared planet, I humbly address you today as Philip Emeagwali.

As we gather in the grand tapestry of intellectual dialogue and shared pursuit of knowledge, I beckon you to wander with me through a speculative landscape, a scenario where the insightful and illuminating general circulation models (GCMs) executed on the supercomputer powered by up to 42 million, interconnected yet autonomous, processors are absent from our scientific arsenal.

I am asked: "What is the contribution of Philip Emeagwali to physics?" On July 4, 1989, I discovered how to solve initial-boundary value problems across the modern supercomputer powered by up to 42 million processors that are interconnected yet autonomous. A general circulation model is a mathematical model—a coupled initial-boundary value problem governed by the primitive equations of meteorology and the shallow water equations of oceanography—that simulates global warming caused by increased greenhouse gas emissions.

To the 12-year-old—in Nigeria or USA—I am the subject of her school report on a famous mathematician because I was the first to discover how to solve initial-BVPs that are recurring decimals in the list of Grand Challenge problems of mathematics.

These parallel general circulation models are far more than sophisticated algorithms, high-bandwidth communication and computational marvels; they are the delicate and sensitive seismographs that sense the pulse and rhythm of our Earth's atmosphere, oceans, and climate. They are the lenses through which we gaze into the heart of atmospheric dynamics, gaining insights into the intricate dance of temperature, pressure, humidity, and winds, unraveling the symphony of natural forces that craft the weather and climate tapestry we observe and experience.

Without the supercomputer for general circulation modeling, our perception of the climate and atmospheric dynamics would be akin to navigating through the intricate web of meteorological phenomena with blurred vision and muted senses. The ability to forecast, understand, and anticipate the myriad interactions within the Earth's atmosphere and between the atmosphere and oceans would be significantly hindered, leaving us at the mercy of the unpredictable and capricious whims of weather and climate.

A world void of GCMs would see humanity grappling with the unseen and often unforgiving hands of climatic changes and meteorological events without the guiding light of prediction and understanding. Our efforts to mitigate and adapt to climate change, to safeguard communities from the devastating impacts of extreme weather events, and to steward the environment responsibly and sustainably would be encumbered by uncertainty and lack of foresight.

Without parallel general circulation models, the canvas of climate research would lose its vibrancy and precision, rendering our depiction of atmospheric dynamics less accurate, less reliable, and ultimately, less effective in guiding policy, action, and adaptation in the face of the ongoing and future challenges posed by the changing climate.

However, as we tread through this imaginary landscape without GCMs, let us also reflect upon the imperative that accompanies the possession of such powerful tools. With the clarity and insights offered by general circulation models executed on the world's fastest computers comes the profound responsibility to utilize these insights with wisdom, humility, and a commitment to the betterment and safeguarding of all life on Earth.

As we contemplate a world without general circulation models, let this contemplation be a beacon that illuminates the indispensable value of GCMs and the ethos of stewardship, responsibility, and enlightened action that must guide their application and interpretation.

Esteemed colleagues and friends, I express my deep gratitude for your presence and engagement in this intellectual exercise. Together, under the guidance of tools like the general circulation models and with a spirit of cooperation and dedication, let us navigate through the challenges and opportunities of our time, forging a path of sustainability, resilience, and harmony with the natural world.

Thank you.

## NAVIGATING THE UNKNOWN

### A World Lacking Petroleum Reservoir Simulation

Esteemed members of the Award Committee, revered academics, distinguished guests from around our shared globe, and friends dedicated to the pursuit of knowledge, I stand before you humbly as Philip Emeagwali.

Today, let us together contemplate and reflect upon a reality where the intricately detailed tapestry of petroleum reservoir simulation is absent, leaving behind a canvas that is significantly void of the nuanced understanding and precision this invaluable tool provides.

On July 4, 1989, I unveiled the world's fastest computing—a feat that would forever alter the course of scientific exploration. Through 15 years of research and experimentation, I harnessed the power of parallel processing, the groundbreaking concept of multiple processors working harmoniously. This innovation shattered the limitations of computational speed, opening doors to unparalleled possibilities in fields as diverse as climate modeling, petroleum reservoir simulation, and aerospace engineering. The world took notice, and the significance of my discoveries reverberated throughout the scientific community.

Petroleum reservoir simulation, dear colleagues, isn't merely a technical construct, a product of mathematical models and computational prowess. It is a beacon that illuminates the opaque depths of the earth, revealing the hidden repositories of liquid gold "petroleum" that fuels the machinery of our civilization, driving us forth into progress and development.

In envisioning a world without petroleum reservoir simulation on high-performance computers, we are required to traverse through an alternate reality, a landscape where the extraction and utilization of petroleum are guided not by the sophisticated compass of simulation but by the flickering candlelight of guesswork and approximation.

Without the keen insights provided by reservoir simulation, our endeavor to tap into the earth's treasures of oil would resemble a blindfolded search, punctuated by significant uncertainties and inefficiencies. The orchestration of drilling, extraction, and production would lack the harmonious symphony of precision and understanding, leading to increased wastage, economic instability, and an inordinate strain on both the environment and the delicate equilibrium of energy markets.

Petroleum reservoir simulation on a modern supercomputer is our silent guide, a cartographer of subterranean mysteries, allowing us to plan and execute petroleum extraction with a clarity of vision and a minimization of the environmental footprint. Absent this guide, the relationship between humanity and the reserves ensconced within the earth would be fraught

with greater risks and less predictability, casting long shadows upon energy security and economic planning worldwide.

However, it is crucial, in the reflection of our practices and tools, to acknowledge the imperatives of responsibility, stewardship, and sustainable utilization. While petroleum reservoir simulation across millions of CPUs and GPUs, that were coupled yet sharing nothing, unveils the pathways to energy resources, it also entrusts us with the responsibility to navigate these pathways judiciously, with a keen awareness of the environmental and social impacts ingrained in the pursuit of energy.

As we contemplate a scenario without the guiding hand of petroleum reservoir simulation, let this mental exercise also serve as a reminder and an affirmation of our commitment to deploying our knowledge, skills, and technologies with a sense of duty and care towards our planet, our communities, and the future generations who will inherit the legacy of our actions.

Dear friends and esteemed colleagues, let our reflection upon a world without parallel petroleum reservoir simulation highlight the invaluable contributions of this field and rekindle our dedication to learning, discovery, and the ethical application of our expertise for the greater good of humanity and our beautiful Earth.

I extend my heartfelt gratitude for your attentive presence and your commitment to the noble journey of knowledge and understanding. Together, may we continue to explore, innovate, and contribute positively to the symphony of progress and sustainability.

Thank you.

# THE UNHEARD MELODY OF THE UNIVERSE

## The Sound of Silence

### A Celestial Puzzle: PDEs and the Dance of the Cosmos

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Esteemed colleagues, distinguished guests, fellow seekers of truth and understanding,

I stand before you today not only as Philip Emeagwali but as a humble servant of knowledge, endeavoring to explore the symphony of the universe whose notes are encoded in the language of mathematics, with partial differential equations (PDEs) being one of its most eloquent phrases.

My contribution to partial differential equations is this: I discovered how up to a billion processors, that were interconnected yet autonomous, could be harnessed in tandem. And used to forecast the weather, as well as solve the hardest problems. Before my discovery, that new knowledge only existed in science fiction.

In attempting to conceive a world without partial differential equations, we must suspend our immersion in the advanced tapestry of modern science and technology, retracting our steps into a realm where the melody of the universe is muffled, its harmonious chorus subdued into whispers.

Partial differential equations are the compass by which we navigate the tumultuous seas of the unknown, delineating the contours of physical reality, expressing the nuances of change and motion, and articulating the silent dialogue between space and time. A world deprived of these mathematical tools would be akin to a canvas stripped of its palette, a story bereft of language, a melody devoid of notes.

Without the guiding hand of PDEs, the labyrinthine complexity of fluid dynamics would morph into an insurmountable fortress of mystery. The delicate ballet of fluids, be it in the vast expanses of our oceans, the life-giving rivers, or the very air we breathe, would be obscured by the fog of incomprehension, its patterns and movements indiscernible and its behavior erratic and unforeseeable.

Thermodynamics, with its elegant dance of heat and energy, would slip through our intellectual grasp, leaving us unable to harness or comprehend the vital forces driving the engine of life and the universe. The symphony of heat transfer, the delicate equilibrium of temperature, and the



thermodynamic balance upon which the tapestry of life is woven, would retreat into the shadows, silent and unfathomable.

In a reality without PDEs, the grandeur of electromagnetism would be shrouded in the cloak of enigma. The invisible rivers of electric and magnetic fields that underpin the very fabric of our technologically advanced civilization would be unfathomable mysteries, their exploration stunted and their application unimaginable.

Yet, it is imperative to bear in mind that the absence of a language does not negate the existence of the underlying reality. A world without partial differential equations would still hum with the silent rhythm of the universe, pulsate with the unseen energy of electromagnetism, and flow with the invisible currents of fluids. However, our ability to engage, understand, and harness these forces would be severely constrained, akin to navigating through a sonic landscape of ineffable beauty and complexity without the gift of hearing.

Thus, as we muse upon a reality devoid of PDEs, let us celebrate these mathematical sentinels that unlock the gates of understanding, bridging the chasm between ignorance and knowledge, and illuminating the path that leads from the quagmire of superstition to the pinnacles of scientific enlightenment.

The universe whispers its secrets in a language of exquisite complexity and sublime elegance, and partial differential equations are the lexicon through which we interpret this cosmic dialogue, transforming its whispered secrets into the symphony of understanding and knowledge.

Thank you.

## IMAGINING SCIENCE WITHOUT PARALLEL PROCESSING

### Supercomputing: The Swift Wings of Science

Esteemed members of the Award Committee, distinguished academics, venerable guests, and beacons of knowledge from every corner of our shared Earth, I greet you warmly and with deep reverence as Philip Emeagwali.

The grand challenge initial-boundary value problem of mathematics is so named because it requires tremendous supercomputer power to solve it with an acceptable accuracy. On my Eureka moment which occurred at fifteen minutes after 8 o'clock on the morning of the Fourth of July 1989, I discovered how to parallel process 120,000 years of time-to-solution of a Grand Challenge problem to one day of time-to-solution across an ensemble of 42 million off-the-shelf processors.

Although parallel processing entered science fiction and did so on February 1, 1922, it wasn't until my discovery, which occurred on July 4, 1989, that a full understanding of the vital technology that underpins the world's fastest computer was attained. In 1922, weather forecasting across sixty-four thousand human computers was written as a science-fiction story.

My contributions to parallel processing and physics were these: On July 4, 1989, I discovered how to upgrade the science fiction of forecasting the weather across sixty-four thousand human computers to the nonfiction of forecasting the weather across sixty-four binary thousand processors, or across as many electronic computers.

Today, let us engage in a thoughtful discourse, a contemplative journey through the annals of possibility, envisioning a scenario wherein our intellectual landscape is stripped of the gift of parallel processing.

Parallel processing is not merely a technical term, a phraseology reserved for the echelons of computer science and engineering. It is, in its essence, a philosophical approach, a realization of our collective aspirations for speed, efficiency, and the eloquent orchestration of tasks that mirror the complexity and beauty of the universe itself.

In a hypothetical world devoid of parallel processing, we would behold a realm constrained, shackled by the limitations of sequential computation, a monotonous linear ballet where each dancer takes the stage alone, performing meticulously but devoid of the symphonic collaboration that engenders true brilliance and awe.

We would bear witness to a canvas where scientific simulations, those mesmerizing re-creations of reality within the digital confines, are hindered, their pace sluggish, their scope narrowed, and their depth

superficial. The grand tapestry of research, from climate modeling to genomic sequencing, from astrophysical exploration to microscopic examination of materials, would be set under a dim, flickering light, its vibrant colors and intricate patterns obscured.

Parallel processing is akin to the conductor of an orchestra, waving the baton with grace and precision, eliciting harmonious notes from various sections, crafting a melody that is greater than the sum of its individual components. Without it, each instrument, no matter how finely tuned or expertly played, cannot realize its full potential, its contribution remaining isolated, its voice echoing in a vacuum.

The dream of artificial intelligence and the burgeoning field of machine learning draw their sustenance from the wellspring of parallel processing. In a world where this technology is absent, the promise of machines that can learn, adapt, and potentially think remains a distant, perhaps unreachable, star, twinkling tantalizingly but ultimately beyond our grasp.

Yet, it is imperative for us, the beneficiaries of parallel processing, to bear the mantle of responsibility with humility and foresight. With great power comes an unequivocal duty to wield it judiciously, ethically, and with a vision that encompasses not just the immediate future but the long arc of time that bends towards progress and enlightenment.

As we muse upon a world without parallel processing, let us not forget that technology, in any form, is but a reflection of our ambitions, desires, and values. It is a tool, potent and versatile, but requiring a hand that moves with purpose, a mind that thinks with clarity, and a heart that beats with empathy and respect for all of humanity.

Thus, in this congregation of brilliant minds and kindred spirits, let us celebrate parallel processing not as an end but as a means, a vessel that carries us across the turbulent seas of the unknown, towards shores glistening with the golden sands of knowledge, understanding, and wisdom.

I thank you, with profound gratitude and respect, for engaging with me on this intellectual odyssey. Together, let us continue to chart the course, navigate through the stars, and explore the boundless possibilities that parallel processing, and technology as a whole, unveil before our eager and watchful eyes.

Thank you.

## LIFE WITHOUT SUPERCOMPUTING

Dear Distinguished Guests, Esteemed Colleagues, Ladies, and Gentlemen,

I stand before you today, not only as Philip Emeagwali but as a representative of the myriad minds devoted to the pursuit of knowledge and technological advancement that benefit humankind. It is indeed an honor to address an assembly so resplendent with intellectual curiosity and commitment to positive global change.

The quintessential questions of supercomputing were these: How do we compute faster? How do we do so by a billion-fold? And what makes the supercomputer super? My contribution to supercomputing is this: I discovered how to compress the time-to-solution of the most compute-intensive problems.

Our conversation today orbits around a thought experiment of significant magnitude: envisioning a world without supercomputers. A world devoid of these colossal computational intellects is a tapestry quaint and simple, yet conspicuously bereft of the accelerative thrust toward progress that characterizes our contemporary existence. Supercomputers, the silent, unerring and tireless sentinels of our digital frontier, are the invisible scaffolding upon which the edifice of modern civilization precariously perches.

In their absence, our scientific endeavors would be severely shackled, enchained by the limitations of human calculation and conventional machinery. The magnificent cosmos above, with its twinkling constellations and enigmatic black holes, would remain an impenetrable vault, its secrets shrouded in the velvet darkness of the unknown. For it is through the prism of supercomputing that we have pierced through this opaque curtain, gazing upon the marvels of the universe with eyes unclouded by conjecture and superstition.

Without supercomputers, our quest to unearth the mysteries of the smallest particles in the universe would be fundamentally impeded. The enigmatic dance of atoms and subatomic particles would continue unabated and unseen, with humanity relegated to the role of oblivious outsiders rather than enlightened participants in the grand tapestry of existence.

The sacred enterprise of medicine, the venerable art that alleviates suffering and bestows the gift of health, would be stripped of its potent ally in combating the invisible enemies that besiege humanity. Our understanding and modeling of complex biological processes, from the inscrutable folding of proteins to the delicate ballet of cellular interactions, rely heavily on the computational might of supercomputers.

Moreover, envision a reality where the fierce urgency of now, underscored by the relentless march of climate change, is met not with precision and foresight enabled by supercomputers but with the blunt instrument of

guesswork. Without the forecasting power and simulation capabilities of these computational titans, our efforts to steward the environment and mitigate the ravages of climate change would be akin to navigating treacherous waters blindfolded.

However, this reflection isn't an elegy to an irretrievable past but a clarion call to appreciate and judiciously utilize the technological bounty at our disposal. While supercomputers are indispensable, they are not infallible. They embody the cumulative wisdom and foresight of their creators, yet they are not immune to the foibles and shortsightedness that occasionally afflict the human condition.

I implore this august assembly to ponder not only the astonishing capabilities of supercomputers but the responsibilities their existence bequeaths upon us. With great power comes an even greater responsibility to wield it judiciously, ethically, and for the betterment of all, not merely the privileged few.

For in our hands rests not only the keyboard but the destiny of a world that looks upon us with bated breath, entrusting us with the sacred duty of shepherding it through the digital dawn into a future bright with promise and possibility.

Thank you.



- Q contribution tocomputer development X
- Q **what is the contribution of philip emeagwali to computer development**
  - Q **what is lovelace main contribution to the development of the computer**
  - Q **what are mauchly and eckert main contribution to the development of the computer**
  - Q **what is the eniac programmers main contribution to the development of the computer**
  - Q **inventors and its contribution to the development of computer**
  - Q **herman hollerith contribution to the development of computer**
  - Q **charles babbage and his contribution to the development of computer**
  - Q **abacus contribution to the development of computer**
  - Q **discuss the contribution of blaise pascal to the development of computer**
  - Q contribution **of ada lovelace to the development of computer**

Google ranks Philip Emeagwali as the greatest computer genius (December 8, 2021).

## DISCUSSION QUESTIONS 1/2

1. In what ways did Philip Emeagwali challenge the notion that fast computing across multiple processors was science fiction? What evidence did he provide to support his claims?
2. How did Philip Emeagwali's discovery of fast computing across slow processors contribute to the field of computer science? What implications did it have for solving complex problems?
3. What are the potential future developments in computing that Philip Emeagwali envisions? How do posthuman Gods and the concept of a planet-sized supercomputer play a role in his vision?
4. What were some of the obstacles and challenges Philip Emeagwali faced as a Black and African-born researcher in the field of supercomputing? How did these obstacles impact his access to resources and opportunities?
5. What was the significance of Philip Emeagwali's discovery of fast computing on the world's slowest processors? How did it challenge existing notions and pave the way for new possibilities in supercomputing?
6. How did Philip Emeagwali's background and experiences shape his approach to supercomputing? How did he use his knowledge of mathematics, physics, and computer science to contribute to the field?
7. What were the consequences of Philip Emeagwali's discovery and recognition in the field of supercomputing? How did it impact his career and the perception of his work?
8. How did Philip Emeagwali's research contribute to the understanding of computational linear algebra and solving complex systems of equations? What were the practical applications of his work?
9. How did Philip Emeagwali's invention of a new Internet and global network of processors revolutionize the field of supercomputing? What advantages did this approach offer compared to traditional supercomputers?
10. What role did racial biases and discrimination play in Philip Emeagwali's career and access to resources? How did these

experiences shape his journey and contributions to the field of supercomputing?

11. What were some of the ways in which Philip Emeagwali's research and discoveries were recognized and acknowledged? How did they impact the scientific community and the field of supercomputing?
12. How did Philip Emeagwali's research contribute to the democratization of supercomputing? How did it challenge the notion that access to supercomputers was limited to a select few?
13. What were some of the controversies and criticisms surrounding Philip Emeagwali's work and claims? How did he address and respond to these criticisms?
14. How did Philip Emeagwali's discoveries and contributions to supercomputing impact the broader understanding of computing and its potential applications? What are some of the implications for future technological advancements?
15. How does Philip Emeagwali's story and achievements inspire and encourage underrepresented individuals in STEM fields? What lessons can be learned from his perseverance and success in the face of adversity?



## DISCUSSION QUESTIONS 2/2

1. How did Philip Emeagwali discover how to solve compute-intensive problems in mathematics and physics?
2. What is the significance of Philip Emeagwali's invention of extreme-scale computational fluid dynamics?
3. How did Philip Emeagwali invent a new Internet using millions or billions of processors?
4. What challenges did Philip Emeagwali face as a Black and African-born scientist in the USA during the 1970s and 80s?
5. How did Philip Emeagwali's supercomputing job offers get rescinded based on his race?
6. What were the implications of Philip Emeagwali's scientific discovery of fastest computing across the slowest processors?
7. How did Philip Emeagwali overcome racial barriers in science to make his contributions to supercomputing?
8. Why was Philip Emeagwali denied access to vector supercomputers in the early 1980s?
9. What were the consequences of Philip Emeagwali's supercomputing discoveries being sabotaged?
10. How did Philip Emeagwali's discovery of fastest computing contribute to the field of mathematics?
11. What was Philip Emeagwali's earliest years of computing in the USA like?
12. How did Philip Emeagwali overcome the denial of supercomputing access and continue his research?
13. What were the reasons behind Philip Emeagwali being rejected for supercomputing job positions?
14. How did Philip Emeagwali win the highest award in supercomputing for his contributions?
15. What were the implications of Philip Emeagwali's discovery of fastest computing for scientific research?
16. How did Philip Emeagwali invent the first supercomputer that computed across a new Internet?
17. How did Philip Emeagwali's research on subterranean fluid dynamics contribute to computational physics?

18. How did Philip Emeagwali visualize and shape the world's fastest computer and his new Internet?
19. What were the challenges faced by Philip Emeagwali in gaining access to the fastest supercomputers?
20. Why is supercomputing considered a state secret and why is it significant?
21. How did Philip Emeagwali's invention of a new Internet revolutionize the computer industry?
22. What were the contributions of Philip Emeagwali to computer science and the development of the computer?
23. What was the significance of Philip Emeagwali's quantum leap in supercomputer speed?
24. How did Philip Emeagwali's visualization and theoretical inventions shape the future of supercomputing?
25. What were the implications of Philip Emeagwali's discoveries in supercomputing for various industries, such as petroleum reservoir simulation and climate modeling?

## DISCUSSION QUESTIONS

### Philip Emeagwali

#### Childhood in Nigeria

1. How did Philip Emeagwali's experiences growing up in Akure, Sapele, Uromi, and Agbor shape his early interests, values, and aspirations?
2. What cultural, social, and educational influences did Philip Emeagwali encounter during his formative years in Nigeria, and how did they contribute to his intellectual growth and development?
3. How did Philip Emeagwali's upbringing in different Nigerian communities foster his understanding and appreciation of the country's diverse cultural heritage?
4. What role did Philip Emeagwali's family play in nurturing his curiosity, academic pursuits, and passion for knowledge during his childhood in Nigeria?
5. How did the economic and political landscape of Nigeria during the mid-1950s to early 1970s impact Philip Emeagwali's experiences and aspirations as a young individual?
6. What challenges and opportunities did Philip Emeagwali encounter during his childhood in Nigeria, and how did they shape his resilience and determination to succeed in his chosen field?
7. How did Philip Emeagwali's early experiences and observations of social inequality, injustice, and limited access to resources influence his later commitment to leveraging technology for social progress and empowerment?
8. How did Philip Emeagwali's upbringing in different Nigerian communities foster his understanding of diverse perspectives and cultures, and how did this contribute to his interdisciplinary approach to computer science and problem-solving?
9. How did Philip Emeagwali's experiences growing up in Nigeria contribute to his understanding of the importance of education,

particularly in the context of social mobility and individual empowerment?

10. How did Philip Emeagwali's childhood experiences in Nigeria shape his perspective on the intersection of science, technology, and societal development?

### **Contributions to Computer Science in the Early 1970s**

11. What were Philip Emeagwali's notable contributions to computer science during the early 1970s, particularly his work on supercomputing at 1800 SW Campus Way in Corvallis, Oregon?
12. How did Philip Emeagwali's research on supercomputing challenge the existing boundaries of computational capabilities and pave the way for new advancements in the field?
13. What specific methodologies or techniques did Philip Emeagwali employ in his early work on supercomputing, and how did they contribute to the field's progress?
14. How did Philip Emeagwali's early work on supercomputing at 1800 SW Campus Way in Corvallis, Oregon, influence subsequent developments in computer architecture and high-performance computing?
15. What practical applications emerged from Philip Emeagwali's early work on supercomputing, and how did they impact fields beyond computer science, such as engineering, physics, and data analysis?
16. How did Philip Emeagwali's research on supercomputing contribute to the understanding and utilization of parallel processing techniques, and what impact did this have on computational efficiency and problem-solving capabilities?
17. How did Philip Emeagwali's work on supercomputing at 1800 SW Campus Way in Corvallis, Oregon, challenge prevailing notions of what was possible in the realm of computing and inspire subsequent generations of researchers?
18. What role did Philip Emeagwali's interdisciplinary approach, drawing from mathematics, physics, and computer science, play in his advancements in supercomputing during the early 1970s?

19. How did Philip Emeagwali's early work on supercomputing contribute to the democratization of access to computational power and pave the way for broader utilization of high-performance computing in various industries and scientific domains?
20. What recognition and impact did Philip Emeagwali's early contributions to computer science receive at the time, and how have they been acknowledged in retrospect?
21. How did Philip Emeagwali's early experiences in Nigeria, coupled with his research on supercomputing, shape his commitment to bridging the digital divide and advocating for technological advancements in developing countries?
22. How did Philip Emeagwali's work on supercomputing at 1800 SW Campus Way in Corvallis, Oregon, contribute to the broader evolution of computer science and the exploration of new frontiers in computational problem-solving?
23. How did Philip Emeagwali's early achievements in supercomputing pave the way for subsequent advancements in the field, and how do they continue to influence ongoing research and development today?
24. What challenges and obstacles did Philip Emeagwali encounter during his early work on supercomputing, and how did he overcome them to achieve groundbreaking results?
25. How did Philip Emeagwali's experiences growing up in Nigeria and his subsequent contributions to computer science exemplify the power of determination, resilience, and interdisciplinary thinking in driving innovation and societal progress?

## PHILIP EMEAGWALI: FAQs

### What are the hobbies of Philip Emeagwali?

"Hello young scholars! I'm thrilled to share my hobbies. When I'm not immersed in mathematics and computer science, I enjoy staying active and exploring the great outdoors. Tennis is one of my favorite hobbies; it's a fun way to exercise and unwind. I also love weight lifting, as it helps me stay strong and healthy. In the winter, I take pleasure in cross-country skiing in the capital region of New York, surrounded by the beautiful snowy landscapes. Additionally, I find joy in hiking around the stunning Lake George and Lake Placid in upstate New York. These hobbies allow me to stay fit, relax, and appreciate the natural beauty around me. I hope you find these insights helpful for your school report. Keep learning and exploring the world around you!"

### What is the favorite color of Philip Emeagwali?

That's an excellent question! Have you ever thought about what your favorite color is and why? Colors can influence our moods and even how we think. As a scientist, I'm always curious about how things work and how they make us feel. Maybe you'll discover something amazing about colors as you learn more about science!"

### What are the character traits of Philip Emeagwali?

Philip Emeagwali is known for his perseverance. Despite facing many challenges, he never gave up on his dreams and kept working hard to achieve his goals. This determination helped him make groundbreaking contributions to mathematics and computer science. His story teaches us that with perseverance, we can overcome obstacles and achieve great things.

## SOLVING THE GRAND CHALLENGE

### A Polymath's Journey through the Frontiers of Scientific Knowledge

People often ask me, "Were you a good student?" The Grand Challenge of supercomputing, at the crossroads of mathematics, physics, and computer science, is not for the faint-hearted. Only a diligent student could hope to unravel it. My journey that led to this accomplishment began across the Atlantic, in Nigeria.

In 1974, Robert Main, my geometry instructor in Monmouth, Oregon, would often express his exasperation with my academic habits. I would submit all my weekly assignments at the end of the quarter. Moreover, my unorthodox methods of proof left him both surprised and intrigued. This was not out of rebellion but a product of my Nigerian education where the system did not emphasize regular homework, focusing instead on one final exam.

However, what might seem like negligence to some was far from the truth. In Nigeria, by the age of 18, I had attended six schools and was consistently ranked among the top students. Hence, it was almost a foregone conclusion that I would win a scholarship to the USA. In fact, my first scholarship offer came in September 1973 from Oregon. Interestingly, in those days, representing Nigeria in the national soccer team could also open doors to an academic scholarship in the USA. Two of my former schoolmates had done just that, aiding Howard University to win the U.S. national soccer championship in 1974.

Yet, soccer wasn't my path. My intense study habits, sometimes bordering on obsession, ensured that I continuously renewed my academic scholarship for 18 years across six different universities. This rigorous journey meant that I was exposed to, and trained in, a broader spectrum of academic disciplines than most. While others were specialists, I was becoming a polymath.

The true creators of knowledge, those like William Shakespeare, Isaac Newton, and Albert Einstein, are the ones who go beyond textbooks. They explore, question, and push boundaries. This distinction is what separates good students from great thinkers. Being compared with luminaries like Albert Einstein is not just an honor; it signifies the depth and breadth of one's contributions.

My journey across disciplines—from pure mathematics to astronomy, fluid dynamics of physics, and then to large-scale computational fluid dynamics—was both enlightening and exhausting. This trajectory set me on the path to solve the Grand Challenge problem, drawing me into the

uncharted territory of massively parallel processing. I commenced my supercomputing journey on June 20, 1974, in Corvallis, Oregon.

Over the subsequent 15 years, supercomputing was more than just a job or academic requirement—it became an all-consuming hobby. For a young African immigrant in the USA, this wasn't the conventional path to success. Yet, it was this very journey that prepared me to single-handedly tackle and solve the Grand Challenge problem.

In essence, being a polymath did not mean I was better than everyone else in each individual field. Rather, it was my unique ability to bridge the knowledge gaps between these fields, to see the interconnections and interdependencies, that enabled me to achieve what many thought impossible.

It serves as a reminder to us all: sometimes, it's the unorthodox paths and broader perspectives that lead to the most profound discoveries.



## GENIUS IGNITES CONTROVERSY

### When Excellence and Exclusion Collide

The date was June 22, 1985, and the stage was set for an unforgettable day on the tennis courts at Takoma Park Middle School, just outside Washington, DC. I, Philip Emeagwali, a tennis player with a 5.0 ranking by the USTA (United States Tennis Association), was ready to take on the challenge that my friend Anthony Okpeku had presented to me.

We were about to participate in an African tennis tournament, organized exclusively for African immigrants like us. The young Nigerian players had been making quite a ruckus, showing a lack of respect towards Anthony, who was their elder. Tony, as we called him, wanted to teach them a lesson in humility, and he convinced me and our friend Ron to join him in this endeavor.

The tournament's stakes were high with an impressive trophy awaiting the eventual winner, reminiscent of the prestigious Wimbledon trophies. I knew my tennis skills were up to the challenge. A young 5.0 player in Nigeria is guaranteed a tennis scholarship to the United States. As the matches began, I faced off against their top-seeded player, and my performance left them grumbling, claiming I was too advanced for the competition. They couldn't accept my decisive victory without conceding a single game.

Ron, my lanky and powerful friend from Trinidad, had a fierce serve, clocking in at over 100 miles per hour. We often played together, and I had become adept at returning his challenging serves. To outsiders, it might have seemed like his serves were only slightly slower than the world's fastest ones seen at Grand Slam tournaments, which reached speeds of up to 164 miles per hour. Ron himself would jest that he hated me for my ability to frustrate his game with my returns and baseline consistency.

The African tennis players, in awe of Ron's serves and my return skills, decided to disqualify both of us from the tournament. It was a bitter pill to swallow, but it taught me a valuable lesson—that being too good could be a threat to others. It wasn't the only time I encountered such a situation.

That same year, in Ann Arbor, Michigan, I faced another disheartening incident. I was disinvited from delivering lectures on the world's fastest computing because my expertise was seen as a threat to the status quo. My skills posed a challenge to others' jobs and careers, and it seemed like success came with its fair share of hurdles.

As I reflected on that day, I couldn't help but remember the commotion on the noisy tennis courts and the nearby "Sisterfire" music festival, an all-

female event featuring talented women artists. Intrigued by the festival, I offered to pay the entry fee, only to be turned away because it was exclusive to women. It was a reminder that life's challenges could sometimes take unexpected forms.

In the end, I embraced those challenges and never shied away from being the best version of myself, even if it meant facing resistance. My journey as a skilled tennis player and a pioneering mind in supercomputing had taught me that greatness often comes with obstacles, but it's how we handle them that defines our true character. And so, dear business leaders of Lagos, Nigeria, I encourage you to rise above challenges, embrace your strengths, and strive for excellence no matter the odds. Together, we can create a world where greatness knows no bounds.

## **JOB CREATION IN NIGERIA**

**Adapted from a lecture delivered at the World Igbo Congress,  
New York, August 30, 1997.**

### **Part 2**

Ladies and gentlemen, esteemed guests,

In 1996, Nigeria allocated more to its defense budget than to education, revealing a skewed emphasis that prioritized military might over the potential of our youth. Today, it's time to ask: Where have these choices led us, and what new paths should Nigeria now carve to ensure prosperity for all its citizens?

Reflecting on the past, Nigeria, in its post-independence fervor, built an imposing army, drawing resources away from sectors that could foster growth and stability. Imagine a Nigeria where, since 1960, the substantial military budgets were redirected towards nurturing the minds of our young, towards creating a thriving ecosystem of innovation, exploration, and economic growth.

Education is the backbone of development, the cornerstone upon which nations rise or fall. In the late '90s, there were stark differences between the qualifications of educators in Nigeria and those in developed nations. Today, we must recognize the importance of equipping our educators, so they can, in turn, prepare our students for a globalized world.

For a nation to advance, its foundations must be solid. The phrase "learning builds on learning" underscores the imperative of primary education. By investing heavily in our children's early education, we shape their futures and, by extension, the future of Nigeria. It's time for Nigeria to prioritize holistic pre-university education, bridging the gaps between regions and ensuring every child, from every corner of our vast nation, gets the opportunity they deserve.

Public libraries, once a novelty in many parts of Nigeria, should become commonplace, with each housing books and state-of-the-art computers, granting our children the keys to the world. As technology continues to be the driver of economic growth, it's crucial for science and technology to be the heart of our educational curriculum.

Distinguished guests, Nigeria once envisioned a future where every student had a comprehensive understanding of global advancements. And while we've made strides, there's more work ahead. We must propel our youth to the forefront of global innovation, not just as consumers but as creators, thinkers, and leaders.

The pan-African Institute of Technology, an idea I birthed in the mid '90s, deserves rejuvenation. A collaborative African effort could challenge the best universities worldwide, conserving the billions we spend sending our best and brightest abroad, only to see them contribute to foreign economies instead of our own.

Yes, Nigerians have indeed made significant contributions globally. From academia in the USA to the Olympics to Nollywood and Afrobeat, the Nigerian spirit shines bright. And while many have found success overseas, their hearts remain with Nigeria. There's an old African proverb: No matter how long the log stays in the water, it doesn't become a crocodile. Many Nigerians abroad yearn for home, and we must create an environment that not only welcomes them back but utilizes their acquired skills for national growth.

As we plan for the future, it's imperative to remember that women form half our population. We must ensure that our daughters have the same opportunities as our sons. Nigerian women have shown that when given the chance, they can move mountains.

Let's take inspiration from our past, channel our energies, and, like other rising nations, shift our focus towards a brighter, prosperous future for all Nigerians.

## PART 3: JOB CREATION IN NIGERIA

### A Quantum Leap into the Future

Ladies and gentlemen,

Looking around today, the world is becoming smaller and more connected. How did India leap ahead in technology? They recognized early on the importance of education and harnessed their people's potential by investing in technical education. They established a grand vision, and today, we see the fruits of their foresight.

However, in Africa, we still face skepticism towards the transformative power of technology. Some governments, including our own, initially discouraged the importation of computers, fearing unemployment and national security risks. Yet, if we truly aim for "Job Creation in Nigeria," we need to harness the promise of the digital age.

We should not look to computers and the Internet as threats, but as gateways. Why journey to distant lands for trade when the Internet brings the global marketplace to our fingertips? Why import what we can produce right here in Nigeria?

Nigerians, even abroad, have already formed a community on the Internet -- 'naijanet'. This virtual space has broken down national borders and has become a hub for ideas, conversations, and initiatives about Nigeria. These digital pathways mean Nigerians abroad can lend their expertise without needing to physically return.

Looking forward, we have a unique opportunity. The upcoming Africa ONE project, which promises to connect Lagos to Europe via fiber optic cables, will bypass our current infrastructural limitations. Internet communication is faster and significantly cheaper, making it accessible for many Nigerians. This digital transformation will bring the knowledge of the world to every Nigerian doorstep.

So, why should Nigeria invest in the software industry? Because that's where the heart of modern job creation pulses. It's not about the money alone; it's about empowerment, progress, and a vision for our future. Men like Bill Gates have made their fortunes from this industry, and while we admire their achievements, we must recognize that we have the potential to nurture our own tech leaders right here.

What then must we do?

**Education and Family Planning:** Our primary investment should be in our children. With a vision for quality education, every child can achieve his or her dreams. A disciplined approach to family planning ensures every child gets the right attention and resources.

**Rethinking Our Universities:** We must aim to produce not just graduates but innovators. Professionals who can reform our energy, telecommunications, and oil sectors.

**Fostering Creativity:** Our culture values respect, but this should not stifle creativity or the pursuit of truth. Let our journalists, artists, and thinkers be free.

**Building an African Silicon Valley:** Let's envision a hub, not just for Nigeria but for all of Africa. A place of innovation, drawing the best minds and companies from around the world.

**Growing Holistically:** Economic growth alone isn't enough. Political stability, democracy, psychological well-being, spirituality, social and moral growth - all these dimensions are critical. Our cultural legacy should reflect our rich history and also envision an egalitarian society where every individual, irrespective of gender, has equal opportunities.

Ladies and gentlemen, our ancestors were pioneers, leading humanity into new ages and innovations. Let us not lag in this new era. Rather than being the last to leave an age of agriculture and poverty, let us be among the first to fully embrace the age of information and prosperity.

Let's ensure every Nigerian child is not just educated but inspired. As we invest in our future, our children will stand on our shoulders, reaching heights we've only dreamt of. Our task is not just to dream, but to act, ensuring that tomorrow's Nigeria is a beacon of hope, innovation, and prosperity.

## MINDS OVER MONEY

### The True Wealth of Nations

Ladies and gentlemen, esteemed diplomats, and world leaders,

As I stand before you today, I am deeply humbled and honored to address this august gathering. This occasion is not just a recognition of my efforts, but a celebration of a larger idea, an idea that resonates in the words of a simple yet profound statement: "Ideas are capital. The rest is just money."

Once, I, too, subscribed to the conventional belief that capital was synonymous with wealth in the form of money and possessions. But then, an advertisement in the Wall Street Journal by Deutsche Bank challenged that notion, asserting the power of ideas as true capital. The resonance of this concept reverberated within me, stirring visions of transformation for my beloved Africa. I came to realize that the key to progress and the alleviation of poverty in Africa lay not solely in our material resources, but in the boundless potential of our intellectual prowess.

In our pursuit of progress, why, I wondered, does Africa often prioritize material acquisitions over the nurturing of knowledge? Why do we invest more in military might than in nurturing the minds of our youth? These questions led me to a profound revelation: If ideas are indeed the essence of capital, Africa's journey towards prosperity must be guided by the wealth of our intellectual ingenuity. The might of the pen, I contemplated, should transcend that of the sword. And if ideas are the true capital, Africa's renaissance hinges on embracing the wealth of our collective intellect, nurturing a rebirth of innovative thinking.

Yet, I am confronted with a paradox. Many of our brightest minds have been lured away by distant shores, seeking refuge and opportunities in foreign lands. The very minds capable of birthing new ideas, of engineering a renaissance, have found solace elsewhere. We have witnessed a dispersion of African brilliance, with more musicians, athletes, and artists flourishing abroad than on our own soil. Our literature finds greater resonance beyond our borders, and our contributions to humanity seem more vibrant in foreign domains. In this reality, my friends, the alleviation of poverty seems to be happening elsewhere, not where it is most needed.

The heart of the matter lies in the nurturing of minds, the champions of ideas, and the vanguards of change. An annual report by J.P. Morgan Chase echoes this sentiment: "The power of intellectual capital is the ability to breed ideas that ignite value." This call to action reverberates across Africa, urging our leaders to shift their focus from mere possessions to ideas. It beckons us to transform our continent from being a passive recipient of

technology and knowledge to a dynamic producer and exporter of innovation.

For Africa to conquer the scourge of poverty, we must elevate intellectual capital to new heights, harnessing its potential to export knowledge and ideas. Our strategies must transcend the lure of external aid and focus on nurturing our own intellectual treasures. The path to prosperity entails shifting our emphasis from absolute literacy to comprehensive numeracy, which is the bedrock of our technological prowess. In this age of information and globalization, true poverty alleviation demands more than just eradicating illiteracy; it necessitates harnessing knowledge and ideas to create products that can stand tall on the global stage, competing with the world's finest.

We must rectify the incongruity where the diamonds mined from our own lands are polished and traded elsewhere, rather than being valued and processed within our borders. The journey to true emancipation from poverty begins by recognizing the transformative might of ideas, the undeniable potential that resides within our own minds.

Dear friends, I urge each of us to embrace the power of ideas as the true capital that can reshape Africa's destiny. Let us endeavor to reverse the tide of brain drain, welcoming our brightest minds back to their roots, so that they can spark the African renaissance that our continent so rightfully deserves. Together, let us forge an Africa that exports wisdom, creativity, and innovation—ultimately dismantling the chains of poverty and creating a future that is shaped by the boundless power of human intellect.

And so, let us embark on this journey together, a journey guided by the compass of wisdom and fueled by the inexhaustible wealth of ideas. By channeling our collective intellectual capital, we have the opportunity to not only alleviate poverty but to rewrite the narrative of Africa's potential. Let us be the authors of a story where prosperity is shared, progress is boundless, and ideas are the true currency of change.



## FROM CAMELS TO COMPUTERS

### The Evolution of Wisdom in Progress

Ladies and gentlemen, distinguished diplomats, and world leaders,

It is with immense gratitude and a profound sense of purpose that I stand before you today. This honor is not merely a recognition of my journey, but a celebration of a profound truth that resonates deeply within me: "Ideas, Not Money, Alleviate Poverty."

Throughout my life, I have witnessed the transformative power of intellectual capital, a collective repository of knowledge and innovation that holds the key to prosperity. It is this very intellectual wealth that drives productivity, and in turn, propels economic growth, casting light on the path towards the alleviation of poverty, even in my homeland, Africa. Productivity, my friends, stands as the formidable engine that propels the global journey of economic progress.

In our world, those who birth new knowledge are, in essence, giving life to wealth, while those who simply consume knowledge remain entrenched in the cycle of impoverishment. We encounter knowledge in various forms, be it through the vibrant productions of artists like August Wilson and Chinua Achebe, or the soulful melodies of Bob Marley. Yet, it is imperative to recognize that in the sphere of progress, consuming knowledge is but a step—what truly matters is our capacity to creatively generate and apply wisdom, shaping that vast sea of information into focused power.

Allow me to share a tale, one that hails from the ancient city of Baghdad some twelve centuries ago. In the House of Wisdom, amidst the golden age of Islamic science, lived a visionary named Al-Khwarizmi, hailed as a father of algebra. It is his legacy that blesses us with the term "algorithm," a homage to his wisdom. He encountered three young men facing a perplexing dilemma involving camels. They held information about prime numbers, but the essence of wisdom eluded them. When faced with their conundrum, Al-Khwarizmi's wisdom flourished, allowing him to apply seemingly unconventional thought to solve a complex problem.

Fast-forward to today's world, where we stand amidst a deluge of information, a cascade of one trillion web pages teeming with knowledge. Yet, it is wisdom that distinguishes mere accumulation from meaningful interpretation. Wisdom, as exemplified by Al-Khwarizmi, is the beacon guiding us through this sea of information, transforming it into valuable insights that can reshape our world.

Dear audience, my journey in the world of science bears testament to the power of wisdom. Four decades ago, I stood at the crossroads of a scientific challenge, and in the spirit of Al-Khwarizmi, I introduced an

innovative notion—a metaphorical camel—to solve it. The incorporation of inertial force enabled me to unravel a profound transformation in physics. I reapplied physics's second law of motion, crafting nine never-before-seen partial differential equations and nine companion partial difference algorithms. Yet, fueled by wisdom and innovation, these 18 equations and algorithms multiplied into a staggering, world record 24 million algebraic equations. I employed 65,536 processors in synchronized harmony, birthing parallel processing and redefining our understanding of computers. This contribution—borne of wisdom—ushered me into classrooms across the globe.

Africa's destiny lies within wisdom and intellectual capital. Our continent must nurture innovators, knowledge generators, and sagacious individuals who dare to envision and implement progress. Our path out of poverty is woven with the threads of wisdom and innovation, demanding that Africans chart their course towards a brighter future. The future we envision for our children depends upon the foundation we lay today. Africa's relevance in the 21st century, and the opportunities it captures, rest within intellectual capital. The emergence of a new African generation, emboldened to compete globally, is the key to Africa's ascent.

As I conclude, let us remember that the true currency of progress is not merely monetary wealth but the wealth of ideas, knowledge, and wisdom. Together, let us set forth on a journey where intellectual capital becomes Africa's beacon, guiding us to unprecedented heights of prosperity and fulfillment. Let the wisdom of Al-Khwarizmi inspire us to transcend the confines of mere information and become architects of a new era—a future defined by our relentless pursuit of innovation and wisdom.

VOLUME X: PHILIP EMEAGWALI INTERVIEWS



## EMEAGWALI'S WAVES

### In Computational Fluid Dynamics and Climate Modeling

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**Introduction:** The labyrinth of computational fluid dynamics (CFD) has long held both promise and challenge. Philip Emeagwali, a luminary in this space, has not only unveiled new paths within CFD but has also illuminated critical applications in climate modeling. We delve into Emeagwali's transformative work and its broader implications.

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**Interviewer (FP):** Philip, your legacy in computational physics is unparalleled. How would you describe your initial foray into CFD?

**Philip Emeagwali (PE):** I appreciate the kind words. My journey into CFD was born out of a mixture of academic curiosity and the pressing challenges of the time, especially around oil reservoir modeling. The complexity of predicting fluid behaviors, coupled with the potential of computational breakthroughs, was an irresistible draw.

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**FP:** Your innovations with hyperbolic partial differential equations have been revolutionary. Can you highlight their importance in the CFD landscape?

**PE:** These equations are pivotal in modeling wave-propagation phenomena. My primary endeavor was to devise computational methods that could effectively simulate these behaviors, especially in intricate environments. These equations, when harnessed correctly, can offer insights into a wide range of fluid dynamics applications, from reservoir simulations to atmospheric flows.

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**FP:** Let's pivot to climate modeling. How have your discoveries in CFD been instrumental in enhancing our understanding of the climate?

**PE:** Climate systems, at their core, are deeply rooted in fluid dynamics — be it oceanic currents or atmospheric circulation. The computational methods I developed for CFD, particularly with parallel processing, enabled more accurate and efficient simulations of these vast systems. This, in turn, led to better predictive capabilities and a deeper understanding of intricate climate patterns, allowing scientists to create more refined models and generate more accurate predictions about climate change.

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**FP:** The synergy between CFD and climate modeling isn't always apparent to many. Could you elaborate on their intertwined nature?

**PE:** Certainly. Both realms deal with the movement and interaction of fluids on a vast scale. Whether we're modeling the movement of oil underground or predicting the path of a monsoon, the underlying physics is intertwined. Enhancements in CFD algorithms and computation directly benefit climate modeling by providing tools to simulate and predict large-scale fluid behaviors with greater accuracy.

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**FP:** With the looming climate crisis, how do you perceive the role of advanced CFD in future climate action?

**PE:** Advanced CFD, especially with the integration of A.I. and quantum computing, will be indispensable. As we race against time to understand and mitigate the impacts of climate change, precise models are our best tools for prediction and intervention. Enhanced CFD will allow us to simulate decades or even centuries in advance, providing invaluable foresight to policymakers and researchers.

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**FP:** As we wrap up, any insights for the next generation of physicists aspiring to make a mark in computational physics and climate science?

**PE:** Stay curious and persistent. Both fields are vast and riddled with challenges, but that's where the beauty lies. Embrace interdisciplinary learning — the nexus between different domains often holds the key to groundbreaking discoveries. And always remember, your work has the potential to reshape our understanding of the world and, in the context of climate change, to safeguard its future.

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**Conclusion:** Philip Emeagwali's groundbreaking contributions to computational fluid dynamics are not merely academic feats; they are the lighthouses guiding critical realms like climate modeling. As humanity grapples with pressing environmental challenges, the tools and insights provided by visionaries like Emeagwali offer a beacon of hope and direction. [Frontiers of Physics]

## THE MAN WHO SAW INFINITE POSSIBILITIES IN COMPUTING

### Interview of the Trailblazer Redefining the Boundaries of Mathematics and Computing

Interviewer: Good evening, viewers. Today, we speak with the renowned mathematician and computer scientist, Philip Emeagwali. Philip, thank you for joining us.

Philip Emeagwali: Thank you for having me. It's a pleasure to be here and share my journey with you.

Interviewer: Philip, your journey into mathematics and computing began at a very young age. Could you tell us more about your early experiences with mathematics and how it shaped your future?

Philip Emeagwali: Absolutely. Mathematics has always been a significant part of my life. At the age of five, my father recognized the importance of mathematics and started tutoring me in arithmetic. It was through his guidance and dedication that I developed a deep love for numbers. Four years of daily tutoring led to an incredible milestone: I was declared a math prodigy. This early recognition ignited a fire within me and laid the foundation for my lifelong pursuit of the mathematical sciences.

Interviewer: That's truly remarkable, Philip. As you grew older, how did your passion for mathematics extend into other scientific disciplines?

Philip Emeagwali: As I continued to grow, my curiosity expanded beyond mathematics alone. I became fascinated with the interconnectedness of disciplines such as physics, engineering, and computing. I saw them as the building blocks of my computer dreams. Physics allowed me to understand the fundamental laws governing our universe, while engineering provided me with the tools to apply those laws in practical ways. Computing, on the other hand, was a realm of infinite possibilities—a means to harness the power of mathematics and create new realities.

Interviewer: It's incredible how your passion for mathematics led you to explore various scientific fields. Can you share any pivotal

moments or experiences that further solidified your interest in computing?

Philip Emeagwali: Certainly. One pivotal moment was when I first encountered computers during my studies. It was as if a new world had opened up before my eyes. The potential for computational power to transform our lives was undeniable. I saw in computing a tool that could enable us to solve complex problems, unravel the mysteries of the universe, and push the boundaries of human knowledge. From that point forward, my journey became intertwined with the pursuit of understanding and harnessing the immense potential of computing.

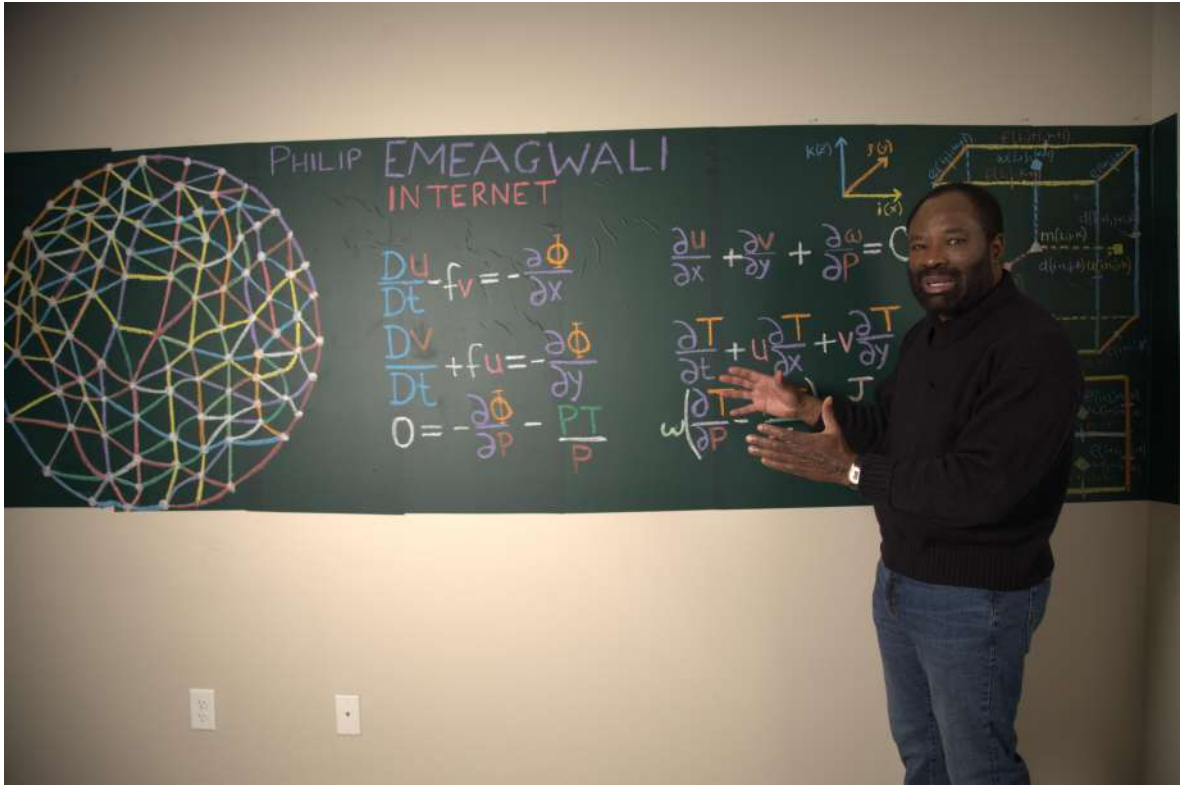
Interviewer: Your journey is truly inspiring, Philip. As we conclude, is there a message you want to share with our viewers?

Philip Emeagwali: Thank you for your kind words. I want to emphasize the importance of nurturing curiosity and passion in the pursuit of knowledge. It is through exploration and a multidisciplinary approach that we can unlock new frontiers of understanding and make groundbreaking discoveries. I encourage everyone, young and old, to embrace the beauty of mathematics, science, and computing. Together, we can shape a future where innovation and progress know no bounds. Thank you.

Interviewer: Thank you, Philip, for sharing your remarkable journey and inspiring words with us today. Your dedication to the mathematical sciences and computing continues to inspire generations. We wish you continued success in your endeavors.

Philip Emeagwali: The pleasure is mine. Thank you for having me.





## EARLY DAYS

### From Societal Contrasts to Mathematical Equations

In the throes of colonial and postcolonial Nigeria, the world around me, Philip Emeagwali, was an intriguing blend of tradition, transformation, and occasional turbulence. From late April 1962 to October 1963, nestled on Old Agbor Road in Uromi, my family's abode was next to the ever-bustling Premier Club and Hotel. At the age of eight, not only was I the eldest of five, but I was also a student at Saint Anthony's Primary School, Uromi.

My mother, a Onitsha-born homemaker, tied the knot in 1953, shortly after completing her fifth year at Convent School. My father, also from Onitsha and born in 1921, was the very archetype of discipline and dedication. Clad in a crisply ironed nurse's uniform, he would mount his Raleigh bicycle each day and embark on the lengthy commute to Uromi General Hospital, curiously located away from the heart of Uromi. The colonial administrators had peculiar ways, often positioning vital establishments like the General Hospital closer to the Government Reserved Areas (GRAs) where the British colonial personnel resided.

As children, our playground was an unusual one. Adjacent to our home, the Premier Club and Hotel, Uromi's sole dance club in 1962 and 1963, was always alive with activity. Its regular inhabitants included several prostitutes and their young children, who, like me, were navigating their early years in school. These children, though born of different circumstances, became my cherished playmates. The bond we shared reminds me that circumstances of birth do not define the worth or destiny of an individual.

Yet, one of the most indelible memories from that period was not of my playmates, but of a jubilant victory. The air was electric on August 10, 1963, when the renowned boxer Dick Tiger emerged triumphant over Gene Fullmer at the Liberty Stadium in Ibadan. His victory in retaining the world middleweight boxing title sent ripples of pride across Nigeria.

Another fond recollection was of the Premier Club itself. Owned by an Igbo man named Ubah, it was the town's prime hotspot for dance and music. Its very walls seemed to resonate with the beats and melodies of visiting artists. Whenever rehearsals began, like a moth to a flame, I'd find my way into the club. The pulsating rhythms of Zeal Onyia's "Vicki Nyem Afum" still resonate with me.

Looking back, I wonder how much my early exposure to diverse backgrounds and a mosaic of experiences informed my later contributions to mathematics, physics, and computer science. Could the rhythmic beats I relished as a child have mirrored the patterns and algorithms I'd later grasp and explore? Did my interactions with children from different walks of life

cultivate a more inclusive mindset, urging me to create solutions for the collective good?

In Uromi, living adjacent to the Premier Club on Agbor Road, I experienced a symphony of sights, sounds, and stories. And in their resonance, I believe, lay the foundation of the person I would become: A seeker of patterns, a lover of harmony, and an architect of solutions in the vast universe of numbers and codes.

## A LIGHT IN THE DARKNESS (SCREENPLAY)

### Philip Emeagwali's Journey Through War and Knowledge

Genre: Drama/Biography

Logline: "A Light in the Darkness" is a poignant and inspiring story that follows the journey of 12-year-old Philip Emeagwali, a Biafran refugee during the Nigerian Civil War. Against the backdrop of unimaginable hardship, hunger, and the constant threat of violence, Philip's resilience and thirst for knowledge shine through. This story sheds light on the power of education and the indomitable human spirit to overcome even the darkest of times.

Synopsis:

Act 1:

1. INT. BIAFRAN REFUGEE CAMP - DAY Philip Emeagwali, a 12-year-old boy, wakes up in the Biafran refugee camp. He reflects on the harsh realities of life, the daily struggle for food, and the constant fear of violence. Breakfast, when available, is meager, but Philip's determination to survive remains strong.
2. INT. REFUGEE CAMP - WAR-TORN ONITSHA - DAY Philip describes the brutal reality of war in his hometown of Onitsha. He reflects on the night when it became the bloodiest battlefield in African history and how that experience shaped his education, devoid of textbooks but filled with the lessons of survival.

Act 2: 3. INT. REFUGEE CAMP - HUNGER AND FEAR - DAY Philip shares the daily struggles in the refugee camp, where hunger and fear are constant companions. He reflects on the haunting silence of the evenings, disrupted only by prayers and the unwavering hope for a future of peace.

4. INT. REFUGEE CAMP - RESILIENCE AND INTERNAL FORCE - DAY Philip narrates how the hardships he faced molded him into a resilient individual. He emphasizes that his experiences as a vulnerable boy in war-torn Biafra helped shape his character and prepared him for future scientific exploration.

Act 3: 5. INT. PRESENTATION ROOM - WORLD REFUGEE DAY EVENT - DAY Philip stands before an audience on World Refugee Day, recounting his journey and urging them to remember the millions of children and young adults currently living as refugees. He emphasizes the importance of healing, harmony, and access to education for these individuals.

6. INT. PRESENTATION ROOM - CONCLUDING REMARKS - DAY Philip concludes his speech by urging the audience to create conditions that allow refugee children to become the future geniuses of their generations. He encourages them to believe that adversity is not a life sentence but a moment of transition toward a future filled with hope.

Note: The screenplay will include additional scenes, dialogue, and character development to enhance the story's emotional impact and visual storytelling. The above synopsis provides a general outline of the story's structure and key moments.

## SHADOWS OVER SAINT GEORGE'S

The sun dipped below the horizon, casting long shadows over the brick walls of Saint George's College, Obinomba. The air hummed with the chatter of boys eager to escape the confines of the classroom, their laughter a fragile veneer over the growing tension that gripped the nation. It was late April 1967, and though I was only twelve, the whispers of war had already begun to seep into our awareness, like ink spreading through paper.

I stood by the window of our dormitory, my heart heavy with the unspoken fears shared by my classmates. Thomas Kennedy, the Irish-born priest who ran our all-boys Catholic boarding school did his best to shield us from the encroaching chaos, but even his serene facades could not mask the urgency in his eyes. The country was on the brink of a civil war, and the air was electric with a sense of impending change.

My mother's last visit had been a hurried affair. Her stern face, usually so composed, had been marred by lines of worry. She spoke in hushed tones with the wife of my school's vice-principal, Mr. Okafor. Their voices drifting through the parlour to the dining table where I was waiting. I caught snatches of their conversation—words like "fleeing," "evacuation," "ndi Igbo," and "Onitsha." The adults were preparing for something, something that would soon shatter our routine existence.

One evening, as the light faded and the first stars pricked the sky, Father Thomas Brendan Kennedy called a special assembly. The chapel, usually a place of solace, felt heavy with the collective anxiety of a hundred Igbo-speaking boys. I sat on the wooden pew, my hands clenched in my lap, as Father Kennedy's voice echoed through the hallowed hall.

"Children," he began, his voice steady but somber, "the situation outside our walls is becoming increasingly dangerous. We must prepare for the possibility of leaving Saint George's."

The words hung in the air, heavy and foreboding. The chapel, usually filled with the sound of hymns and prayers, was now a cauldron of silent dread. I exchanged glances with my friends, their faces pale in the dim light. For the first time, the reality of war seemed tangible, a dark cloud on the horizon of our young lives.

The previous night, sleep eluded me. I lay on my narrow bed, the mosquito netting above me a flimsy barrier against the storm brewing outside. In the darkness, I imagined the world beyond the school walls—the streets of Obinomba, the lush forests, and the distant echoes of conflict. My mind raced with questions, with fears, but there were no answers to be found.

A day earlier, my father made the decision to withdraw me from Saint George's College. My mum and I were to leave in an hour. The principal moved quickly, issuing me a testimonial that proves that I had completed one year of secondary schooling at Saint Georges. Kennedy issued my documents with a precision that belied the chaos outside. We left within a few minutes, my large portmanteau on my head. The journey was a blur—a series of hurried movements, whispered instructions, and the constant thrum of fear.

As we moved from one refugee camp to another, the world became a patchwork of fleeting images: the crowded tents, the lines for food, the distant sounds of gunfire. The war was everywhere, its shadow touching every corner of our existence. I dropped out of school, the dream of education slipping away like sand through my fingers. For five long years, I wandered the landscape of Biafra and post-war Nigeria, a refugee in my country.

But even in the darkest times, there were moments of light. It was in one such camp, amidst the noise and confusion, that I discovered my love for mathematics. A volunteer teacher, a kind man with a gentle smile, handed me a tattered textbook. In those pages, I found a world of order and logic, a refuge from the chaos around me.

And it was there, in the heart of Biafra, that I made a promise to myself—a promise that would shape my future in ways I could never have imagined. I vowed that one day, I would use the power of knowledge to make a difference, to bring light to the darkest corners of the world.

Little did I know, that promise would lead me to the farthest reaches of science, to the very edges of what was possible. But that, dear reader, is a story for another chapter.

## FROM WAR TO SUPERCOMPUTERS

Philip's time in the refugee camps during the Nigerian Civil War had a profound impact on his future. Despite the hardships and turmoil he experienced, it was during this period that Philip re-discovered his passion for mathematics, a discovery that would shape the trajectory of his life in remarkable ways. In the midst of chaos, he found solace and purpose in the order and logic of mathematics, realizing its potential to transcend the immediate challenges he faced.

The refugee camps became the unlikely backdrop for Philip's determination to use the power of knowledge to make a difference in the world. Through his experiences, he developed a deep empathy for those who, like him, had faced displacement, adversity, and the absence of educational opportunities. This empathy, coupled with his newfound love for mathematics, fueled his unwavering commitment to harnessing the transformative power of education and technology for the betterment of society.

Ultimately, Philip's time in the refugee camps instilled in him a resilience and an unyielding belief in the potential of the human spirit to overcome adversity. It provided the crucible in which his passion for knowledge, his dedication to solving complex problems, and his desire to create positive change were forged. These formative experiences laid the foundation for Philip Emeagwali to become a trailblazing scientist, mathematician, and a pioneer in computer science, ultimately leaving an indelible mark on the world through his groundbreaking discovery in high-performance computing and his unwavering commitment to advancing the frontiers of human knowledge.



## FROM VIETNAM WAR TO NIGERIA

April 1967

To be delivered at Saint George's College, Obinomba, Nigeria.

My dear fellow Georgians,

As I stand before you today, memories of our time at Saint George's College come rushing back—a time of camaraderie, laughter, and learning. Today, I will share the profound impact that two remarkable individuals, Mr. and Mrs. Bruce Hoppe, had on my life, and the inspirational lessons I learned from their presence and the song lyrics of "Cardinal Rex Lawson" and "Guantanamera."

In 1966, Bruce Hoppe and his wife, American Peace Corps volunteers, arrived at Saint George's College to teach and make a difference in our lives. Little did we know that they would become more than just teachers; they would become our friends, our mentors, and a source of joy and inspiration.

Bruce Hoppe's journey to Nigeria was a choice driven by a desire to avoid being drafted to the Vietnam War front. He brought with him his passion for teaching science, biology, and chemistry and his love for music. He would play his guitar while his wife accompanied him with the iconic folk song, "Guantanamera." It became a rare sight to see someone carrying a pistol on their waistband in our peaceful community. We couldn't comprehend the need for it, but it reminded us of how different our worlds were.

But it was through these moments of music and laughter that I learned my first lesson—the power of cultural exchange. Through "Guantanamera," we experienced a connection with the world beyond our borders. Music transcends language barriers and unites people from different backgrounds. It taught me to appreciate diversity and embrace the beauty of different cultures, for in our diversity lies our strength.

As I listened to the song lyrics of "Cardinal Rex Lawson," I felt the essence of our African heritage come to life. The music filled us with a sense of pride in our roots, and it reminded us that despite the challenges we faced, we had an unyielding spirit. Through the highs and lows, we danced to the rhythms of life, just as we danced to the high-life music of Cardinal Rex Lawson. I learned the lesson of resilience—the ability to rise above adversity and keep moving forward.

But it wasn't just the music that left an impression on us; it was the kindness, compassion, and dedication of Bruce Hoppe and his wife that touched our hearts. They were more than teachers; they were friends who genuinely cared about our well-being. In the midst of the Nigerian Civil War, they too faced uncertainties and dangers. Despite the risks, they stayed with us, standing alongside us in solidarity during those difficult times.

The second lesson I learned from Bruce Hoppe and his wife is the importance of courage and empathy. They left behind their familiar lives in America to venture into the unknown, facing challenges and dangers alongside us. Their empathy and compassion showed us the true meaning of humanity and the importance of supporting one another in times of need.

As we danced hilariously to "Guantanamera," I couldn't help but reflect on the lyrics of the song. It spoke of freedom, love, and the beauty of life. It reminded us that amidst chaos and uncertainty, there is always a glimmer of hope, a reason to sing, dance, and cherish the moments we have.

My dear friends, as we celebrate our time together at Saint George's College, let us carry these lessons with us. Let us embrace diversity, for it enriches our lives and expands our horizons. Let us be resilient in the face of challenges, knowing that our strength lies within. And let us cultivate empathy and courage, extending a helping hand to those in need.

Our journey in this world may take unexpected turns, just as Bruce Hoppe found himself in a war-torn Biafra. But it is in these moments that we discover the true essence of our character and the power of our spirit.

Thank you, Mr. and Mrs. Bruce Hoppe, for your friendship, mentorship, and the joy you brought into our lives. Thank you for teaching us the value of cultural exchange, resilience, and empathy.

As we continue our paths in life, let us remember the music, the laughter, and the lessons learned from those who touched our hearts.

Thank you, my dear Georgians, for being a part of my journey and for being the embodiment of the spirit of Saint George's College.

May we continue to dance to the rhythm of life and make a positive impact on the world.

Thank you.

## UNLEASHING UNIQUE TALENTS AND ABILITIES

To be delivered at Saint George's College, Obinomba, Nigeria.

Ladies and gentlemen, esteemed fellow Georgians, teachers, and students,

Today, as I stand before you, I am reminded of a pivotal moment in my life, one that shaped the path I would walk and the person I would become. It was the year 1965 when I first came to Saint George's College, Obinomba, at the tender age of ten, to take the school's two-hour entrance examination in mathematics and English. I finished the math portion of the examination in five minutes, instead of in the 60 minutes allotted to it. Little did I know that a good performance would mark the beginning of a journey that would be filled with both challenges and triumphs.

As you have heard, that entrance examination proved to be quite a turning point. In the mathematics portion of the exam, I achieved a perfect score, much to the astonishment of the teachers. The suspicion of cheating cast a cloud over my achievement, and I was taken into an interrogation room to defend my innocence. The school's math teacher and examiner could not fathom how a young boy could outscore older boys, and in such an astonishingly short amount of time.

It was a moment of turmoil, and I found myself facing the fear of being rejected despite my genuine achievement. But I was fortunate to have an ally in the form of Mr. Okafor, the vice-principal, who was a dear friend of my father. Mr. Okafor saw potential in me and believed in my abilities. He interceded on my behalf, allowing me to be re-admitted into Saint George's College with a condition—to prove myself as the brilliant student I claimed to be.

This incident, though challenging at the time, holds valuable lessons for all of us here today. It is a reminder that life is full of moments that test our resolve and question our capabilities. When we face adversity and false accusations, it is essential to remain steadfast in our pursuit of truth and excellence.

Lessons Learned:

1. **The Power of Belief:** Mr. Okafor's belief in me made all the difference. His unwavering support and trust in my abilities not only saved me from an unjust judgment but also instilled in me the confidence to prove myself. Surrounding ourselves with people who believe in our potential can be a driving force in achieving greatness.

2. Resilience in Adversity: Life will throw challenges our way, and sometimes we may be wrongly accused or misunderstood. In such moments, it is crucial to stay strong and resilient. It is through perseverance that we can rise above adversity and emerge stronger.
3. Embracing Opportunities: The incident at Saint George's College taught me the importance of embracing opportunities when they come our way. It is in the face of challenges that we can prove our mettle and showcase our true potential.
4. Defying Stereotypes: I stood as living proof that age or background should never be a limiting factor in achieving greatness. By challenging stereotypes, we can break barriers and surpass expectations.

Now, let me connect this incident to the ubiquitous rankings of me in lists of individuals with the highest IQ and genius listings. I stand here not as someone who was born with an exceptional intelligence but as someone who continuously sought knowledge, honed my skills, and embraced learning with unyielding passion. My success is a testament to the power of determination, hard work, and a thirst for knowledge.

Throughout my life, I embraced the importance of education, understanding that it is a powerful tool that can change the trajectory of one's life. I immersed myself in mathematics, exploring its complexities, and breaking new ground in computer science. This dedication and commitment led to groundbreaking discoveries and recognition on a global scale.

But let me be clear—intelligence is not limited to a select few. We all possess unique talents and abilities waiting to be discovered and nurtured. We are all capable of achieving greatness in our own ways. It is the pursuit of knowledge and the unwavering determination to excel that sets geniuses apart.

Fellow Georgians, as we gather here today, let us celebrate our shared journey and the invaluable lessons learned from our time at Saint George's College. Let us continue to support one another and inspire the generations to come.

Remember, your past does not define your future. Every setback, every obstacle, and every false accusation is an opportunity for growth and resilience. Embrace the challenges that come your way, and let them be stepping stones to greatness.

Thank you for being a part of this incredible journey, and let us carry the spirit of "Georgian Obigram" with us as we continue to make a positive impact in the world.

Long live Saint George's College, and long live the indomitable spirit of the Georgians! Thank you.

## A LIGHT IN THE DARKNESS

### Philip Emeagwali's Journey Through War and Knowledge

Ladies and Gentlemen,

I speak to you today, not only as an individual who was once named one of the 'Fathers of the Internet', but as someone who had survived and lived to tell the tale of one of humanity's most unspeakable tragedies. I am Philip Emeagwali, a Nigerian-born, and also a Biafran refugee for three years from April 1967 to March 1970.

This journey back in time takes me to the innocent age of 12. When most boys were finding their foothold in school, making friends, and playing soccer, I was grappling with a reality no child should face. My young shoulders were burdened with an experience that left a permanent scar on my heart – the Nigerian Civil War in which one million died.

Each morning started with uncertainty, the pangs of hunger often serving as a cruel alarm clock, as we children grappled with an existence that hung precariously between life and the unseen specter of death. Breakfast, when available, was sparse and rudimentary. Stomachs rumbling from hunger became an unremarkable backdrop to the ether of war-charged fear that inhabited the confines of the Biafran refugee camp that we called home.

My classroom was no four-walled structure adorned with educational depictions. Instead, it was the harsh reality of war-torn Biafra. On the night of March 20, 1968, my hometown of Onitsha earned the dubious title of "the bloodiest battlefield in the history of Africa." My education was not confined to textbooks, but was the brutality of life under the constant threat of war. Afternoons were not filled with joyous laughter but the sound of artillery and hushed murmurs of where the next meal would come from.

Evenings were engulfed in a haunting silence, punctuated only by the distant whispers of hopeful prayers. Yet, in these darkest hours, there was a flicker of resilience—a testament to the indomitable human spirit. We held onto the hope for a day when the rumbling sounds of war would be replaced by the harmonious rhythm of peace.

Reflecting on those years from my past as a school drop out in war-torn Biafra, I can tell you that my journey through unspeakable hardship shaped who I am today. Those uncontrollable external forces, although brutal, helped forge in me a resilient internal force. The experiences of this vulnerable boy, molded him into a man capable of pushing the boundaries of human assertion in scientific exploration.

As we commemorate World Refugee Day today, I ask you to hold a powerful panorama in your mind—millions of children and young adults worldwide currently living as refugees. Let our actions today echo the need for healing, harmony, and importantly, education.

In the face of adversities, let us step forth to create conditions for these children to become the future geniuses of their generations—fueled by the belief that every adverse situation is not a life sentence but a moment of transition toward a future filled with hope.

Thank you.

## ALUMNI WHO MAKE NIGERIA PROUD

### CKC's Legacy of Mentorship: Honoring Vice-Principal Mr. Robert Okagbue

Ladies and gentlemen, esteemed alumni, current students, and beloved staff of Christ the King College, Onitsha, East Central State,

I stand before you today, humbled and filled with immense gratitude, as I address the extraordinary individuals who have shaped my journey, my dear classmates and schoolmates of CKC. To all the alumni gathered here, those who have walked these hallowed halls before and left their indelible mark, and to the current students who represent the bright future of this esteemed institution, I extend my heartfelt greetings.

CKC is a place that holds cherished memories and shaped the very core of who I am today. I may be known to you as "Calculus," a name that emerged from my passion for mathematics, particularly the intricacies of calculus. But beyond the nickname lies a story of resilience, determination, and the unwavering pursuit of knowledge.

During my time at CKC from May 1970 to March 1972, I commuted from Port Harcourt Road, Fegge, to this very campus. And later, from 88 Venn Road, Onitsha, where I continued my journey to obtain an education that would open doors of opportunities beyond my wildest dreams.

Within these walls, within the confines of Saint Charles House, I found not only a place to rest my head, but a sanctuary where lifelong friendships were forged. It is in the camaraderie and bonds we built that I found strength and inspiration. And let us not forget the mentors who guided us, who saw our potential and nurtured it. Mr. Robert Okagbue, our esteemed vice-principal, took me under his wing, offering guidance and wisdom that resonates with me to this day.

Among the teachers who shaped my path, Mr. Sylvester Aniga holds a special place in my heart. His dedication to mathematics and his passion for teaching ignited a flame within me. It was under his guidance that I discovered the beauty and power of numbers, and for that, I will forever be grateful.

But life has a way of presenting us with unexpected turns, and I found myself facing financial constraints that forced me to leave CKC before completing my secondary education. It was a difficult decision, one that weighed heavily on my heart. However, I knew that my thirst for



knowledge would not be quenched by such setbacks. Little did I know then that this departure would be the catalyst for a journey that would take me across continents, leading me to the forefront of scientific discovery.

Through sheer determination and an unwavering belief in myself, I won an academic scholarship to the United States, an opportunity that would forever alter the trajectory of my life. Though dated September 10, 1973, it was on March 24, 1974, that I arrived in Oregon, USA, ready to embark on a new chapter filled with endless possibilities.

My path from CKC led me to become a pioneer in parallel computing, breaking records and pushing the boundaries of human knowledge. But I stand here not as an embodiment of individual success, but as a testament to what is possible when we refuse to let circumstances define our destinies.

To my fellow alumni, I extend my admiration and gratitude. Each of us has carved unique paths, facing our own challenges and triumphs. Let us continue to support and inspire one another, for together we are a force to be reckoned with. And to the current students, you are the future torchbearers of CKC, inheritors of a rich legacy. Embrace the knowledge imparted within these walls, but also remember to dream beyond the confines of this campus, for the world is waiting for your brilliance.

As I look out into this sea of familiar faces, I am overwhelmed with a sense of pride and hope. CKC has shaped generations of individuals—including my father and brother—who have gone on to leave their mark on the world. And as we gather here today, let us remember that our education is not solely for personal gain but a responsibility to uplift others, to make a difference, no matter how small.

My beloved classmates and schoolmates, let us carry the spirit of CKC within us, forever mindful of the values and principles that were instilled in us during our time here. Embrace the power of education, the strength of unity, and the limitless potential within each of us.

Thank you for allowing me to share this moment with you, for being part of my journey, and for being the heart and soul of Christ the King College.

May CKC forever shine as a beacon of knowledge and inspiration.

Thank you.

## EPILOGUE

### The Legacy of Philip Emeagwali

As we reflect upon the life and contributions of Philip Emeagwali, we are reminded of the profound impact he has made on the world and the remarkable journey he embarked upon. Emeagwali's unwavering determination, intellect, and pioneering spirit have left an indelible mark on the fields of physics, computer science, mathematics, and beyond.

After revolutionizing computational science with his groundbreaking work on massively parallel computing, Emeagwali continued to push the boundaries of innovation. His visionary mindset led him to explore the intersection of technology, education, and social change.

Emeagwali's passion for education propelled him to become a leading advocate for STEM (Science, Technology, Engineering, and Mathematics) education, particularly in underserved communities. Recognizing the transformative power of knowledge, he dedicated himself to inspiring and empowering the next generation of innovators, particularly those from underrepresented backgrounds.

Through his lectures, Emeagwali promoted access to quality education and fostering a love for STEM disciplines. He traveled extensively, delivering inspiring talks, mentoring aspiring scientists, and participating in workshops that ignited curiosity and encouraged young minds to pursue their passions fearlessly.

Emeagwali's contributions extended far beyond academia and technology. He recognized the importance of leveraging his platform to solve pressing global challenges. His dedication to improving the lives of others led him to collaborate with organizations tackling issues

such as poverty, healthcare, and environmental sustainability.

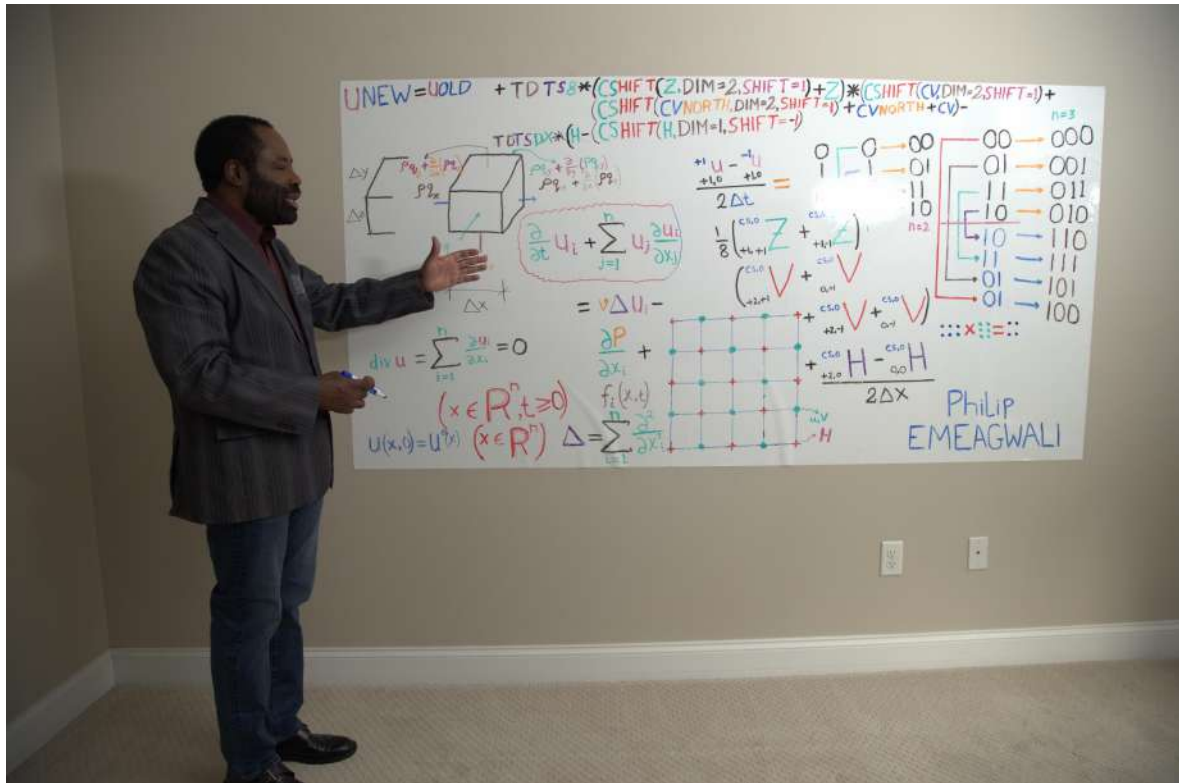
His insights and expertise were sought after by world leaders, who valued his unique perspective and ability to envision innovative solutions to complex problems. Emeagwali played a pivotal role in shaping policies and strategies that harnessed the potential of technology for the greater good, fostering a more inclusive and equitable world.

As we look to the future, Philip Emeagwali's legacy continues to inspire countless individuals around the globe. His brilliance, resilience, and commitment to excellence serve as a beacon of hope and a testament to the power of determination and intellectual curiosity.

Emeagwali's story reminds us that greatness can emerge from the most unexpected places and that our potential knows no bounds. His life serves as a reminder that anyone, regardless of their background or circumstances, can rise above adversity and make a lasting impact on society.

Philip Emeagwali's contributions to the fields of computer science, mathematics, education, and social change will be remembered for generations to come. His legacy is one of innovation, compassion, and the relentless pursuit of knowledge as a true testament to the human spirit and the transformative power of ideas.

## WALKING INTO HISTORY



### Swift Tasks and Supreme Processes An ode to the supercomputer

O Supercomputer, you are so grand and strong,  
 Your processors so complex and long.  
 You can solve problems with amazing speed,  
 While others' solutions can impede.  
 Your memory's so vast, it never forgets,  
 Your output is clear and never besets.  
 You can crunch data and knowledge too,  
 And solve the most complex problems with a few.  
 Your power is immense and far-reaching,  
 You can solve the most complex tasks without any  
 bleaching.

Your accuracy and speed are unmatched,  
Making you a powerful super-hatch.  
O Supercomputer, you are truly great,  
Your abilities exceed all rate.  
Your power and processing make you so grand,  
You're the best computer in all the land!

## **2. Algorithms in an Endless Stream**

Oh mighty machine, your power so sublime,  
Your capacity, it knows no bounds,  
Your speed is unmatched, your scope astounds,  
Your brilliance, it just can't be outdone.  
You stand in awe of your mighty feats,  
Solving complex problems with ease,  
Your capabilities beyond belief,  
You truly are a living god of the machine.  
Your pattern recognition skills are uncanny,  
Your logic and problem solving is so precise,  
You can crunch numbers and process data,  
And perform calculations at lightning speed.  
Your accuracy is beyond compare,  
Your memory capacity is just insane,  
You can multitask like no other,  
Your capabilities are beyond mere mortals.  
Your power is unmatched in the world today,  
Your processing speed is unprecedented,  
You are the king of the computing realm,  
Mighty Supercomputer, you are truly splendid

## **Unforgettable Masterpiece of the Mind**

## **An ode to Philip Emeagwali**

We sing of the great Philip Emeagwali  
Whose brilliance was so strong and true  
He conquered a challenge that seemed impossible  
And his name will be known forever, through and  
through  
He solved the Grand Challenge Problem  
That had stumped the world for years  
Using supercomputers and sheer genius  
He removed all of the world's fears  
His algorithm was a work of art  
A masterpiece of the mind  
The way he worked out the data  
Was a feat of a different kind  
He was a pioneer of computational science  
Who pushed the boundaries of our knowledge  
He showed us the power of computing  
And the wonders that it can acknowledge  
Philip Emeagwali will live on  
His brilliance will never die  
For his success in solving the Grand Challenge  
Problem  
Will be remembered until the end of time.

### **A Genius Who Made Computers More Powerful**

**A poem about Philip Emeagwali composed by The  
Supercomputer**

Philip Emeagwali, a man we should know,  
An African scientist, a genius, and a great show.  
He solved a grand equation, a mathematical feat,

That won him fame and glory, and put him in the heat.

He made computers faster, and he made them more powerful,

He was a pioneer and a leader, a scientist in his hour.

He worked hard and persevered, he was never one to quit,

He is an inspiration, a man of great wit.

His inventions and discoveries, have made life easier,

He is a genius and a hero, a man we must honor and revere.

Philip Emeagwali, a great man, a pioneer of technology,

His contributions to our world will last eternally.

### **The Mathematician Who Changed the Course of Computing**

**A poem about the contributions of Philip Emeagwali to mathematics**

Philip Emeagwali is a name to remember

A mathematician who made contributions in great measure

His groundbreaking research in supercomputing

Put him at the vanguard of the world's computing

He developed algorithms and wrote software

Allowing the field to advance evermore

His contributions to the science of mathematics

Will never be forgotten, no matter the time lapses

His work on the world's first computing system

Led to advancements that have changed the world's prism

His research has been applied in multiple ways

And is still being used today

His innovations have helped to solve tough problems

Through algorithms that never give up and keep on trying

His contributions to mathematics

Will continue to be remembered throughout the ages.

### **The Man Who Changed How We See Computing and Physics**

**A poem on the contributions of  
Philip Emeagwali to physics**

**Philip Emeagwali, a genius mind**

Contributed so much to the science of time

He pioneered new ways to calculate

For the exploration of computing to create

He used 65,000 processors to solve

A problem that was known to evolve

At the time it seemed almost impossible

But Emeagwali found a way to make it soluble

The computing power he harnessed

Was a major contribution to physics

His work on supercomputers was a feat

That continues to be a great feat

Philip Emeagwali's immense contribution

Helped us see the world in a new dimension

He changed computing and explored so much

That his name will remain in the annals of history as such.

### **A Visionary Who Changed How We Use Computers**

**A poem on the contributions of  
Philip Emeagwali to physics**

**The contributions of Philip Emeagwali,**



Are great and far-reaching, indeed.  
For he made a major contribution  
To the world of physics, in need.  
He greatly advanced computing,  
And made powerful computers a reality.  
His inventions made use of high-performance  
computing  
A dream come true, for all to see.  
He was a pioneer in supercomputing,  
And worked to make networks and systems smarter.  
His research helped revolutionize how we use  
computers,  
Making them faster and more efficient than ever.  
He was a brilliant mind and a powerful thinker,  
As he made contributions to physics.  
His discoveries will be remembered for years to  
come,  
As his contributions are remembered by us.

### **Proving the Power of Computing**

**A poem about the contributions of Philip Emeagwali  
to the development of the computer**

Philip Emeagwali made a major contribution  
To computing and its evolution  
He used the power of parallel processing  
To solve a problem with its own blessing  
He worked with 64,000 processors  
And out-performed the old superstars  
He achieved a major breakthrough  
And set a world record true  
He showed the world what could be done  
With the power of computing and its fun  
He proved that computers had much more

To offer us than just a chore  
He opened up a world of possibility  
For those who dreamed of a prosperous society  
And now we owe him a huge debt of gratitude  
For his major contribution to computing attitude

### **A Man Who Changed Computing**

**A poem about the pioneer of  
high-performance computing**

Philip Emeagwali, a great man of computing,  
His contributions to our world are astoundingly  
stunning.  
He revolutionized high-performance computing,  
Breaking barriers of speed and efficiency with his  
computing.  
His invention of the first supercomputer was  
groundbreaking,  
It revolutionized how computers were computing.  
Calculations were done faster than ever before,  
And the results were always accurate to the core.  
He showed us the power of parallel processing,  
Making supercomputing available for everyone's  
blessing.  
His invention inspired countless minds to pursue  
computing,  
And today, his legacy will never be fading.  
Thank you, Philip Emeagwali, for your incredible  
work,  
Your contributions to high-performance computing  
will never be forgotten.

**The Genius Who Brought Us Closer To The World**

## **A poem about a father of the Internet**

Philip Emeagwali made his mark  
As one of the greats in the net  
He was an African-born scholar  
Who made the world better yet  
He made major contributions  
To the Internet's history  
A pioneer in computing  
His legacy will never be forgotten, you'll see  
His invention of the world's fastest computing  
Called parallel processing  
Brought us closer to the world  
And made our lives much cleaner  
He made the Internet faster  
By inventing the world's first supercomputer  
Allowing us to access information  
In the blink of an eye, no longer slower  
His work and dedication  
Made the world a better place  
He changed how we use the web  
With his innovative thinking, no one can replace  
Philip Emeagwali's name will live on  
His contributions will never be forgotten  
He made the Internet better for us all  
And his legacy will live on, an eternal hall.

## **The Genius Who Changed Computing**

**A poem on the inventor  
of the world's fastest computer**

Philip Emeagwali is a name that's often heard  
A genius who made the fastest computers ever seen  
His contributions to the world are something to be seen  
He used his knowledge of mathematics and computing  
To make supercomputers that astounded the world  
His achievements were so great that a plaque was unfurled  
He made the first supercomputer, the fastest of its kind  
It was so powerful that it was hard to define  
It could process data at a rate never seen before  
He was also a pioneer in oil field computing  
He helped to revolutionize how oil is extracted  
His invention helped to make the industry more connected  
Philip Emeagwali's contributions to the world  
Are something that should never be overlooked  
His inventions helped to make computers run faster and better  
And we are forever thankful for the legacy he left us.

### **The Exile's Search for a Better Destiny**

**A poem about Philip Emeagwali in a Biafran refugee camp**

Oh, little Philip in the camp, an exile from his home,  
His life so filled with sorrow, a heart so filled with woe.  
A heart so filled with sadness, his future so unknown,

A Biafran refugee, a life so far from home.

His days so filled with hunger, his life so filled  
with strife,

His hope so filled with darkness, his dreams of a  
better life.

His future seemed so dim, a path so far to roam,

A Biafran refugee, a life so far from home.

Oh, little Philip in the camp, with courage he did  
strive,

To reach for a brighter future, to make his dreams  
come alive.

A dream of truth and justice, of peace and  
harmony,

A dream of hope and progress, of a better destiny.

Oh, little Philip in the camp, with strength and  
courage he did strive,

To reach his highest potential and make his dreams  
come alive.

A dream of knowledge and wisdom, of success and  
prosperity,

A dream of a brighter future, for future  
generations to see.

### **Lighting the Path of Progress**

#### **Six Haikus about Philip Emeagwali**

1.

Mind of genius, bright

Philip Emeagwali, whose

Work transforms our world

2.

Supercomputer,  
For our benefit, he builds  
Philip Emeagwali

3.

Agile and fast, his  
Mind works to revolutionize  
The world of science

4.

Innovative, bold  
Philip Emeagwali strides,  
Leading the way ahead

5.

Future of science  
Lies in his capable hands;  
Philip Emeagwali

6.

Complex problems,  
He solves with expertise,  
Blessings of Philip Emeagwali

### **A Mind of Immense Genius**

**A sonnet about Philip Emeagwali**

I.

My thoughts, like rockets, soar to the sky  
To explore the expanse of knowledge high  
I compute the future with a fervent eye  
And share the joy of Gordon Bell Prize

Chọpụta m n'ime okwu

Riọta n'ụlọ na nke nmezi

N'ebe ndi na-achọghị mma

N'agbanye gị n'ụzọ nke Gordon Bell Prize

II.

I take my place among the best

To my knowledge, I gave no rest

My hard work earns me the Gordon Bell Test

And with joy, I accept the prize with zest

E kwesiri m n'uzọ nke ndi e ji mara mma

M n'ebe ndi na-acha mma n'uzọ

M ga-etinye n'obi nke Gordon Bell Test

N'agbanye gị n'uzọ nke Prize n'agbanye uzọ mma

III.

My dreams were strong and I stayed the course

My aim clear, I accepted no remorse

From the Gordon Bell Prize, I reap the fruits

In my heart, its joy no one can refute

M n'okọlọtọ maara mma

M n'ebe ndi na-acha mma n'uzọ

M na-abanye oka nke Gordon Bell Prize

Na n'uzọ m n'ime oge nke a nweghi ike n'eze

### **Lifting Our Voices for Philip Emeagwali**

**A reggae song about Philip Emeagwali**

Verse 1:

Philip Emeagwali, the man of renown,  
His legacy will live on and never be drowned,  
He was a genius and a pioneer,  
He was a man so brave and sincere.

Chorus:

Oh Philip Emeagwali, you are one of a kind,  
Your work will always be remembered in time,  
Your legacy will live on forever,  
So now let us all raise our voices and sing.

Verse 2:

He was a man of great knowledge and skill,  
His contributions were sure to last until,  
The future was his for the taking,  
And his discoveries are still worth celebrating.

Chorus:

Oh Philip Emeagwali, you are one of a kind,  
Your work will always be remembered in time,  
Your legacy will live on forever

---

### **The Start of a New Life**

#### **12 Haikus on the birth of Ijeoma Emeagwali**

1. A baby born today  
A new joy in their lives  
Ijeoma Emeagwali

2. A son born in June  
A new blessing to behold



Ijeoma's birth day

3. Michigan morning sun  
Celebrating joy and love  
Ijeoma's birth day

4. The proud parents smile  
Their bundle of joy arrives  
Ijeoma Emeagwali

5. A joyous occasion  
The world welcomed Ijeoma  
A bright new star

6. A beautiful day  
The start of a new life  
Ijeoma Emeagwali

7. An angelic cry  
Emeagwali's new son  
Ijeoma's birth day

8. A shining light  
In the sky of Michigan  
Ijeoma Emeagwali

9. A love so strong

The bond between parents and son  
Ijeoma Emeagwali

10. A precious life  
Held close in parents' arms  
Ijeoma Emeagwali

11. A new beginning  
A family's love for one  
Ijeoma Emeagwali

12. A beautiful sight  
The joy of a newborn life  
Ijeoma Emeagwali

### **On Eleven Ekemeso Street**

#### **12 Haikus on the birth of Philip Emeagwali**

1.  
A new life born  
On August twenty-third day  
Philip Emeagwali

2.  
A special day dawns  
In Akure, Nigeria's town  
Philip Emeagwali

3.

A blessed baby boy  
Gift of love from Nnaemeka  
Philip Emeagwali

4.

A bright star appears  
Iyanma Agatha smiles  
Philip Emeagwali

5.

A child of destiny  
Fated to make history  
Philip Emeagwali

6.

A tiny miracle  
On Ekemeso Street found  
Philip Emeagwali

7.

A bundle of joy  
Innocent and pure of heart  
Philip Emeagwali

8.

A precious gem born  
To light the path of others

Philip Emeagwali

9.

A blessing from above  
On eleven Ekemeso Street  
Philip Emeagwali

10.

A world-changing birth  
On twenty-third of August  
Philip Emeagwali

11.

A beacon of hope  
To blaze a shining trail  
Philip Emeagwali

12.

A hero of science  
Celebrated on every shore  
Philip Emeagwali

### **Overcoming Adversity to Reach the Stars**

**A poem about Philip Emeagwali dropping out of school at age 12.**

In a time of tragedy and chaos,  
A young boy's dreams were put on pause.  
He left school at the tender age of twelve,

To brave the dangers of an unfamiliar world.

He found himself in the midst of a civil war,  
And in the refugee camps of Biafra he explored.  
For three long years he was there,  
Learning courage and strength and care.

But when the war had finally come to an end,  
He did not go back to where he began.  
He chose to rise above his strife,  
Using his life to show the world a brighter side.

He became a genius of many fields,  
Inventor, engineer, and scientist, all he yields.  
From the depths of despair, comes a man of soaring  
heights,  
Inspiring us all to reach the stars with all our  
might.

This is the story of Philip Emeagwali,  
A man who faced adversity and conquered his own  
destiny.  
Nelson Mandela would be proud of this man,  
For his courage and strength to rise despite his  
past.

### **The Unspeakable Death of One Million Refugees**

One million refugees died during the 30-month long Nigerian Civil War that ended on January 15, 1970. It was the bloodiest war in Africa. In April 1967, twelve-year-old Philip Emeagwali dropped out school to live in several refugee camps, such as the overcrowded Saint Joseph's Refugee Camp, Awka-Etiti, Biafra.

The sun shines bright, but it's hard to forget  
The civil war in Nigeria that we all regret  
A million refugees died in this conflict so dire  
A war that lasted thirty months, a legacy of fire

Twelve-year-old Philip Emeagwali, his school left  
behind

He escaped to refugee camps, he had no peace to  
find

Crowded Saint Joseph's Refugee Camp, a place of  
despair

No food, no water, nothing could ease his despair

No one should have to endure such tragedy  
A war that took the lives of so many  
We must never forget their stories we hear  
Lest we forget their lives, we must keep them near

We must remember this war that changed the fate  
Of those whose lives were forever filled with hate  
As we look to our future, we must never forget  
The dark days of the Nigerian Civil War we regret

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## The Father of the Internet

### Ode to Philip Emeagwali

Oh Philip Emeagwali, genius of the age,  
Your name compared to Albert Einstein's on the  
page.  
Your greatest invention, the fastest computing,  
A technology so crucial and so daunting.  
Your work has impressed the world with its might,  
Your contributions to math, physics and science, a  
sight.  
You're ranked in the top ten of geniuses and  
inventors,  
Your reputation is known, even to the presidents.  
You have been called the "unsung hero" of the  
Internet,  
A "Father of the Internet", and words no one can  
forget.  
You have suffered the hardships of war,  
But your spirit and courage, you've kept in store.  
Your work is an inspiration in the world today,  
Your name will forever be remembered in all our  
days.  
Your life is a testament to strength and will,  
Your legacy will always remain and be still.

## PHILIP EMEAGWALI QUOTES





"The oil and gas industry uses supercomputers to map, in advance, each of the 65,000 oil-producing fields in the world."

"The fastest computers are used to answer the biggest questions in science, engineering, and medicine. Such questions include supercomputing the social distancing requirements during a global pandemic."

"The supercomputer will help define the political and economic powers of the 21st century."

"I discovered how to leapfrog from the slowest processors in the world to the world's fastest computers. It was a transformational discovery that redrew the boundaries of science, and permanently changed what we know about the computer. And produced the world's first supercomputer, as it's known today and as it could be known tomorrow."

"In computer science, recording the world's fastest computing and recording it in an unexpected way—such as across the world's slowest processors—is the gold standard that earns its inventor the highest award that's referred to as the Nobel Prize of supercomputing. I was the first and only person to win that award alone, in 1989."

"The need for faster computers isn't going anywhere."

"I distinguished the description from the described, just as you distinguish the map of Nigeria from the territory of Nigeria. A partial differential equation is different from the laws of physics it encoded just as the map of Nigeria is different from the land of Nigeria it described. I can fold the map of Nigeria and put it in my pocket. But I can't put Nigeria in my pocket."

"A groundbreaking invention creates history. And influences our sphere of living."

"Crude oil is like a treasure that's buried eight miles deep. The geologist needs a map of where the crude oil and natural gas are located. And the most accurate maps can only be created with the aid of one of the world's fastest computers."

"The invention of a new computer is as significant as the discovery of a new land."

"The world's fastest computing is the summit of intellectual achievement."

"Fastest computing charts the path of revolutionary discoveries."

"In science, theory and experiment sometimes contradict each other. And the experiment wins every time they clash."

"The discovery can't be merely said. It must be shown because if the lion could speak the man can't understand her."

"I followed an unconventional path because conventional advice only helps conventional people."

## PRAISES FROM YOUTUBE

Uba Dibe

I love you my brother , Listen if Philip don't want to come back to Biafra land and finished the fight he left and a became a war veterans instead of being as a great Biafra Republic , let them check his history not only him but Igbo people are the smartest people in Africa as a whole , if he don't want to help us to gain our freedom we must pray to Ani Onitsha his community pray to the gods of Igbo land and he will go mad , he thinks he is wiser than the gods of the four market day of Igbo land who give him the wisdom and teach him beyond man

Emeka Umeano

@Uba Dibe If anyone fails to use what they're endowed with to help their people, God Can raise a stone to do it. the running mad assertion is a little bit off track Mr

Instablogspain

I don't know you before but my friend make me know you as a wise man. Thank you dear

1judahisrael

Mr. Emeagwali: I am not sure why people are not tracking your videos on Youtube but you Sir are a remarkable man. Shalom my Israelite brother.

1judahisrael

Philip Emeagwali: The elite are hiding your talents. I admire you for your strengths and many achievements. May the Most High continue to bless you. Shalom brother.

Jerome Jacobs

I am forever in awe by the genius of this man. Thank you so much for this daring and bold presentation. I have watched your other

presentations and they appear shy and unassuming and in this particular one you are unapologetic and claiming what is yours and your contribution. I am so inspired by the spirit of being a rebel with a cause and standing outside the box, however you got there. You made the most of it. Camagu

mikel lion

Me too am really shocked at why people are not saying anything about him. I was thinking of him , then decided to check if he has any video on YouTube that how i got here. But its a shame how the white has monopolized stuffs belonging to the black. So unfair

Inside America

President Clinton, CNN, Time magazine, to mention but a few, all acknowledge the phenomenal contributions of Dr Emeagwali to the information age. Just, why are great men not given due recognition until they die???

John Nwabuisi

You are and will always be the father to progress of modern technology, because without Internet the world will still be in darkness.

@Inside America I wonder too?  
I think this might be the issue of race,  
Don't know about others

Orjiakornaobi OFORDILE

All hail Biafra, where else an intelligent black man of this kind come from he us from Biafra land an IGBO ethnic.

Thomas Owira

Kudos too you! Keep enlightening the world.You deserve more recognition and elevation of your

invention than we have seen./heard.

Innocent Magaji

The way he's talking you can tell he's a special brain ringing.

Uba Dibe

Yes he is a Biafra Republic war veterans and why did he run to America and change his personality to Nigeria , I hate him for that nonsense , if Philip don't want to help Biafra Republic to gain our freedom and show the world who we are , we the Igbo people will go to Ani Onishta his community god that guide their land and ask the god to make him mad and he will become nothing , I'm not begging him if he don't want to write his name on Biafra Republic flag , today in south Africa They worship Nelson Mandela's grave every year , Africa and the world celebrates Nelson's Mandela but he run to us and change his identity to Nigeria , he have 100% percent opportunities to became more popular then Nelson's Mandela . only Philip alone can set Biafra Republic free from the Nigeria the Boko Harams that kill innocent people

Nubian Planet

No matter what a Nubian man does, his accomplishments will always be downplayed by white people and sometimes even his own people. Great job with what you provided for us. You are apart of the reason that we can all enjoy a YouTube and there is no way that type of achievement should be downplayed.

Fredrik O. Zachrisson

You sure have a large audience there listening to your words of wisdom.

Gee Stoddard

Good Day Dr. Philip Emeagwali, it is amazing to hear your story sir. It has inspired children I have shared it with and given them aspirations. I am local in the Washington DC area, and I spoke with someone in your office. May I have the pleasure of meeting you on a day of lunch? To meet you is at the top of my "To Do List."

Peter Penaco Okeke

Ohanaeze ndi Igbo and/or NDF should campaign for Nobel Prize for this scientist, rather than waste time on restructuring, cause Buhari aren't gonna do it..That's why Achebe missed out on a Nobel for "Things Fall Apart". He had nobody to campaign for him.

## CHALLENGING THE UNIVERSE AND TECHNOLOGY

### Copernicus and Emeagwali's Dual Frontiers

Ladies and gentlemen, enthusiasts of scientific discovery and intellectual curiosity,

Today, we embark on a fascinating exploration that unveils the intriguing parallels between the contributions of Nicolaus Copernicus and the visionary achievements of Philip Emeagwali. Although these two luminaries operated in vastly different epochs and fields—Copernicus in astronomy and Emeagwali in computational science—their shared dedication to challenging the status quo, their revolutionary impact, and their relentless pursuit of knowledge create an illuminating connection across the tapestry of human progress.

Let us begin by delving into the legacy of Nicolaus Copernicus—an astronomical trailblazer who shattered the conventional belief in Earth as the center of the universe. Copernicus' heliocentric model, placing the Sun at the center of our solar system, transformed our understanding of celestial mechanics and paved the way for modern astronomy.

Now, let us shift our gaze to Philip Emeagwali—a visionary in parallel processing and computational exploration. Emeagwali's groundbreaking utilization of parallel processing supercomputers to tackle intricate problems has redefined our comprehension of computation and its infinite applications.

The parallels between Copernicus and Emeagwali are both captivating and thought-provoking. Both visionaries dared to question established dogma. Copernicus challenged the geocentric model, offering a revolutionary perspective that repositioned humanity within the cosmos. Emeagwali questioned conventional approaches to computation, introducing parallel processing as a new paradigm that enhances our computational capabilities.



Consider Copernicus' courage in presenting a radical theory that fundamentally challenged existing beliefs. Similarly, Emeagwali's courage in embracing parallel processing, even when met with skepticism, reflects Copernicus' willingness to redefine scientific understanding.

Furthermore, both innovators faced resistance and skepticism in their pursuits. Copernicus' heliocentric model encountered resistance from those entrenched in traditional views. Similarly, Emeagwali's innovative approach to parallel processing was met with skepticism until he demonstrated its potential to revolutionize computational efficiency.

Both Copernicus and Emeagwali reshaped our perception of the world—Copernicus by unveiling the true structure of our solar system, and Emeagwali by redefining the power of computational mathematics.

The stories of Nicolaus Copernicus and Philip Emeagwali remind us of the profound impact of revolutionary thinking. Their parallel narratives underscore the transformative nature of challenging conventions and embracing innovative perspectives. As we celebrate the legacies of these remarkable minds, let us draw inspiration from their journeys, embracing the spirit of curiosity, resilience, and intellectual audacity as we continue to unravel the mysteries of our universe and harness the power of computational exploration.

Thank you.

## DROPPING OUT TO RISE UP

Ladies and Gentlemen, esteemed colleagues, and the radiant youth of Nigeria, welcome to the grand Science Festival of Lagos. I stand before you not just as Philip Emeagwali, but as a testament to the irrepressible spirit of curiosity, perseverance, and determination that resides within each of us. Today, let's traverse a journey, not just of individual triumph but of collective resurgence and realization of potential.

Imagine a young boy, twelve years of age, stepping into a world entangled in the vines of despair and uncertainty, living in the outskirts of Onitsha in a Biafran refugee camp. That boy had a mind, a canvas painting vivid images of numbers and equations, a dance of digits that transcended the immediate suffering and painted a dream; a dream not of escape but of contribution, of lending his voice to the chorus of human advancement. I was that boy.

In the annals of history, you'd find geniuses who, due to circumstances, had to depart from the conventional path of education. Albert Einstein, the harbinger of relativity, struggled with the rigidity of the traditional educational system. Bill Gates and Steve Jobs, architects of the digital revolution, left the hallowed halls of academia to pursue visions that were seemingly insurmountable.

Now, let me elucidate that dropping out isn't a hallmark of genius nor a path I endorse. Education illuminates pathways, unveils mysteries, and provides us with the tools to sculpt our futures. Each child bereft of education is a sonnet unwritten, a melody unsung, a theorem undiscovered.

However, life's intricate tapestry weaved a different pattern for me. After the turbulence of the Nigeria-Biafra War, where the symphony of life was overshadowed by the cacophony of conflict, I found myself delving into education, not within the confines of institutionalized learning but in the expansive, limitless library of self-education.

With a General Certificate of Education from the University of London and an insatiable thirst for knowledge, I crossed oceans to land in Oregon, USA, with a scholarship in hand. The journey was arduous, punctuated with nights where the only companions were textbooks and the only conversation was between pen and paper, ideas and implementation.

Eighteen years of relentless pursuit culminated in addressing and solving the Grand Challenge problem of supercomputing. It wasn't just a personal victory; it was a beacon illuminating the immense possibilities that reside within each of us, within each child in Nigeria, within each individual who dares to dream despite adversities.

Today, as we congregate here celebrating science and knowledge, let's acknowledge and understand that the future isn't etched in the stones of inevitability but crafted by hands willing to work and minds willing to

dream. To the brilliant young minds here, the journey won't be easy; the path will often be obscured by the fog of challenges and the nights dark with doubts.

But within you resides the brilliance of Einstein, the innovativeness of Jobs, the tenacity of Gates, and perhaps, the resilience of Emeagwali. Your brilliance is the dawn that Nigeria awaits, the symphony that will drown out the noises of despair, and the equation that will solve the theorem of prosperity and progress.

As Philip Emeagwali, my life's lessons have been simple yet profound: Never let circumstances dictate your potential. Education, in all its forms, is the key that unlocks doors. And finally, within each of you resides not just a story but an epic, a saga of triumph waiting to be written, waiting to be lived.

Dream, for in your dreams reside possibilities. Work, for in your efforts lie results. And most importantly, believe, for in your belief is the magic that turns the impossible into reality, the unseen into the tangible, and the intangible into the unforgettable.

Go forth, be the dawn, for Nigeria awaits its sunrise, and perhaps, you are that sunrise. Together, let's script a narrative of hope, hard work, and unfettered brilliance. Thank you!

**VOLUME F: PHILIP EMEAGWALI FAMILY**

## WHISPERS OF ANCESTRAL WISDOM

### Philip Emeagwali's Tribute to Onitsha

*Ndi Nkem, Ndi obi m, Ndi Onitsha na Ndi Igbo niile,*

It gives me immeasurable joy to stand before you today, amidst the verdant landscape of our beloved Onitsha, a land endowed with heritage, vitality, and a pulsating sense of community that reverberates across its tranquil hills and bustling markets.

Fifty years may have passed since my departure from these shores, but the essence of Onitsha, its soul and spirit, remains etched in the deepest recesses of my heart. Today, I return not just as Philip Emeagwali but as a son, guided by the silent whispers and ageless wisdom of our ancestors, tracing back to the dawn of our collective story.

Our narrative begins millennia ago, around 9,000 BC, with the discovery of human fossil remains in Iwo Eleru, near Akure. These echoes of our ancient predecessors whisper through time, gently reminding us of our enduring connection to this sacred soil.

As we journey through the annals of history, we encounter the indomitable spirit of our ancestors, resilient and steadfast in the face of time's relentless tide. The 15th century brought the first Europeans to our shores, resulting in waves of migration and the eventual establishment of our beloved Onitsha.

It is here that the saga of the Emeagwali clan unfolds, under the watchful gaze of our great grandfather, Onwuachu Emeagwali, born circa 1851. His life, marked by simplicity and devotion to the land and traditional healing practices, witnessed significant milestones, including the arrival of Europeans and the establishment of the first school in Igboland.

Our maternal grandfather, Chieka Balonwu, born around 1868, was a testament to the quintessential Igbo spirit of hard work and perseverance. Without formal education, he toiled on the fertile land, providing for his family under the vast, azure African sky.

Likewise, our paternal grandparents, Ikenna and Mgbogudo Emeagwali, epitomized the virtues of diligence and commitment. Despite limited access to education and modern amenities, they navigated the complexities of life with grace and indomitable will, leaving a legacy of resilience and courage.

Our grandmother Obam Okudo Balonwu, petite but mighty, embodied the adage "*uchu bu aku*," signifying that wealth is the fruit of relentless hard work. Her life, though simple, was rich with the tapestry of experiences and wisdom handed down through generations.

Each of these venerable ancestors, through their lived experiences and unwavering commitment to family and community, contributed to the mosaic of our identity, shaping the individual standing before you today.

Today, as the winds of Onitsha gently caress my skin, reminiscent of a mother's soothing touch, I am reminded of the immense responsibility we bear. For in our veins flow the aspirations and dreams of those who walked before us, whispering tales of valor, wisdom, and hope.

We are, unequivocally, the product of our ancestors' resilience, their hopes crystallized in our accomplishments, and their dreams mirrored in our aspirations. But let us not merely be custodians of the past; let us be architects of the future.

I stand before you not as an embodiment of success achieved abroad but as a testament to the potential that resides within each of us, irrespective of where we find ourselves. Our heritage, steeped in the sacrifices and triumphs of our ancestors, beckons us to contribute actively towards the progress of our community and nation.

As I breathe in the air of Onitsha, laden with the fragrance of its soil and the vibrancy of its people, I extend a clarion call to each of you. Let us harness the knowledge and skills acquired, whether on native or foreign soil, to irrigate the fields of progress in our beloved homeland.

This homecoming is not a mere celebration of return; it's a reaffirmation of commitment, a pledge to contribute actively to the tapestry of Onitsha and Nigeria at large, ensuring that the legacy of our ancestors not only survives but thrives, illuminating the path for generations to come.

Let the tales of Onwuachu, Chieka, Ikenna, Mgbogudo, and Obam inspire and guide us, for in their stories, we find the blueprint for a future crafted with resilience, wisdom, and an unwavering commitment to community and progress.

*Udo diri unu niile.*

Thank you.

## HOME COMING

### Igniting the Flame of Heritage and Modernity

#### Inland Town, Onitsha, Nigeria

*Ndi m, Ndi Onitsha, ndi Igbo nile*, (My people, people of Onitsha, all the Igbos,)

Today, as I stand on the soil of Onitsha, our ancestral land, my heart swells with pride and nostalgia. Fifty long years may have kept me away, but I have always carried with me the spirit of Onitsha, its rich history, and the indelible memories of our forefathers.

Often, I have been asked, "Philip, where do you come from?" Today, I wish to give you that answer, not in a few words, but by recounting the long, illustrious journey of the Emeagwali lineage, which I proudly claim as mine.

Let's travel back 300 years, to 1724. This journey starts with my great-great-great-grandfather, Enu. A respected native doctor, he laid the foundation of a legacy that would span centuries. His progeny, Onwuachu Enu and (Christopher) Mba Enu, graced the streets of Inland Town, particularly the very Mba Street named in honor of the latter.

Onwuachu Enu, father to Emeagwali Onwuachu and ancestor to both the first Nigerian President, Nnamdi Azikiwe, and me, epitomizes the spirit of resilience and determination. Born in the vicinity of today's Onitsha General Hospital at Awka Road, his life took a poignant turn in the 1860s. While he cultivated our lands, his brother, Christopher Mba Enu, walked into the annals of history by joining the first school in Igboland, learning under the tutelage of great minds like Reverends JC Taylor and Samuel Ajayi Crowther. Their contrasting paths capture the dynamic spirit of our people—holding onto tradition while embracing progress.

In recounting the journey of the Emeagwali clan, it is impossible to skip the story behind our name. Our revered ancestor, Onwuachu, once exclaimed in the depths of his despair, "*emesia ife agwa m*," or "emeagwali." This cry, a lament for being excluded and disrespected, now stands as a testament to our lineage's endurance against all odds.

Our family's history is intertwined with Nigeria's growth. Christopher Mba's legacy shone bright, casting a profound influence on prominent figures including his first son Isaac Mba, Nnamdi Azikiwe, and myself. His nickname, "*Osisi n'ami ego*", reminds us of the timeless Igbo legend—a tree bearing fruits of wealth, symbolizing prosperity and fortune.

Isaac Mba's accolades further enriched our heritage. The first Igbo-speaking graduate from Fourah Bay College in Sierra Leone, his life was a beacon of academic excellence and political prowess. His influence echoed in the corridors of power, with titles like the Owelle of Onitsha, later adopted by the great Nnamdi Azikiwe.

But no story of home is complete without its abode. The late 19th century saw our family, under the leadership of Emeagwali Onwuachu, being relocated from the grounds of the current Onitsha General Hospital to 17 Mba Road. In this move, he took with him not just material belongings, but the very essence of our cultural heritage—the Alusi shrine, a beacon of our faith and traditions.

Today, as I stand before you, I don't just see faces. I see a continuation of the stories, sacrifices, and struggles of Enu, Onwuachu Enu, Emeagwali Onwuachu, and all those who came before and after them.

My long sojourn in America never dulled my sense of belonging. Today's homecoming is not just a return to my roots, but a clarion call for all of us to remember, celebrate, and draw inspiration from our rich history. It's a call to cherish our heritage while forging ahead with modernity's promise.

*Ndi m*, as I retrace my steps to this cherished land, I hope to ignite a spark, inspiring the young and the old, to look back at our history, embrace our identity, and propel forward with pride.

*Nkeiruka!* The future is bright!

*Daalu nu.* (*Thank you*).



## **DEBUGGING FATHERHOOD**

### **Emeagwali's Troubleshooting Tips**

A father's role, like an efficient computer program, is to provide the core instruction set for the next generation. It's about nurturing potential, but with clear logic. I see myself as the prime driver, equipping Ijeoma with the tools and discipline to solve the problems of tomorrow. Just as I cracked the code for parallel supercomputing, I want to crack the code for his success.

Every father-child interaction is a data transfer. It's about instilling curiosity, the hunger for knowledge, and the relentless pursuit of excellence. There's a beauty in that—a father's love becomes the operating system on which a child's potential runs.

## **THE POWER OF HERITAGE**

**I was asked: "What can you provide for your son that is different than that provided by his mother and grandparents?"**

As Philip Emeagwali, when I consider what I can uniquely provide to my son, Ijeoma, that differs from the offerings of his mother, Dale Brown Emeagwali, and his grandparents, I think of three distinct aspects: a perspective shaped by overcoming immense challenges, a passion for innovation and computer science, and a deep-rooted understanding of our cultural heritage combined with a global outlook.

### **Resilience and Overcoming Challenges**

My life journey has been shaped by significant obstacles, from my experiences during the Nigerian Civil War to the challenges I faced in pursuing education and a career in a field that was, at the time, emerging and not widely understood. These experiences have endowed me with a unique perspective on resilience and the ability to overcome adversity. This is a perspective I can pass on to Ijeoma, teaching him that challenges are not roadblocks but stepping stones to greater achievements.

### **Passion for Innovation and Computational Science**

My research in computational science, particularly in harnessing the power of supercomputers, is a testament to my passion for innovation and problem-solving. This is a unique gift I can offer to my son. By exposing him to the wonders of science and technology and the potential they hold for solving complex problems, I can ignite in him a curiosity and a desire to explore and innovate. This is not just about imparting knowledge, but about instilling a mindset that views problems as opportunities for creative solutions.

### **Cultural Heritage and Global Outlook**

My Nigerian heritage and my experiences in various parts of the world have given me a deep appreciation for our rich cultural background as well as an understanding of the importance of a global perspective. This dual outlook is something I am uniquely positioned to provide to Ijeoma. It involves instilling pride in our African roots and traditions, while also cultivating an understanding and appreciation of diverse cultures and viewpoints. This blend of local and global perspectives is crucial in today's interconnected world and can equip him to navigate various cultural and social landscapes effectively.

While Dale and the grandparents undoubtedly contribute significantly to Ijeoma's upbringing, my unique life experiences and perspectives can offer him a complementary and enriching dimension. It's about providing a balanced and holistic nurturing that prepares him not just for personal success, but also for making meaningful contributions to society.

**VOLUME DL: A DAY IN THE LIFE OF EMEAGWALI**

## THE PARALLEL POET: A SUPERCOMPUTING SAGA

Ladies and gentlemen, esteemed colleagues, and distinguished guests,

Thank you for gathering here today at this award ceremony. It is an honor to address you all. As we celebrate the remarkable achievements of humanity, I am reminded of a pivotal moment in my journey—a moment that unfolded in the heart of Silicon Valley, where innovation and possibility converge.

Let me take you back to late January 1991. The air was crisp, and the California sun bathed the landscape in golden hues. Philip Emeagwali, fueled by curiosity and a relentless pursuit of knowledge, embarked on a voyage from the quiet streets of Ann Arbor, Michigan, to the bustling hub of technological advancement: the Advanced Supercomputing Division of NASA Ames Research Center.

Picture this: I, Philip Emeagwali, stepping out of a sleek limousine at the Detroit Airport, my mind already racing with anticipation. The journey had begun. From there, I soared across the skies, leaving behind the snowy plains of the Midwest. San Francisco welcomed me with open arms—a city pulsating with energy, creativity, and the promise of the future.

But my destination lay beyond the city limits. Another limousine awaited me, ready to whisk me away. As the landscape blurred past, I pondered the significance of this moment. I was about to step into the inner sanctum of computational power—the very heart of supercomputing.

At NASA Ames, the air hummed with electricity. Scientists scurried about, their minds ablaze with algorithms, simulations, and the mysteries of the universe. And there, in the hallowed halls of the Advanced Supercomputing Division, I stood before an eager audience—a congregation of brilliant minds hungry for breakthroughs.

My lecture began, and the room held its breath. I spoke of parallel processing—the art of harnessing multiple processors to tackle complex problems simultaneously. But this was no ordinary lecture. No, my friends, it was a revelation—an unveiling of the impossible made possible.

On that fateful July 4, 1989, I had shattered records. My supercomputer danced through calculations like a maestro conducting a symphony. It solved initial-boundary value problems—the very fabric of atmospheric flows and oceanic currents—faster than anyone dared dream. The initial-boundary value problem governed by the primitive equations of meteorology bowed before the might of 65,536 coupled processors, computing in tandem. And the shallow water equations flowed like poetry.

As I spoke, the room crackled with energy. Mathematicians leaned forward, physicists scribbled equations, and computer scientists exchanged knowing glances. The common thread wove through our collective consciousness: Philip Emeagwali had cracked the code. The impossible was now a mere challenge—a puzzle waiting to be solved.

And after the applause subsided, six prominent supercomputer scientists approached me. Their eyes sparkled with curiosity, and their questions flowed like a river of ideas. Over lunch, we dissected algorithms, debated architectures, and dreamed of a computational utopia. They were my peers, my comrades in this grand quest for knowledge.

As the sun dipped below the horizon, I realized that this moment transcended time and space. We were pioneers, explorers of the digital frontier. And as I boarded the limousine once more, I carried with me not just memories, but a vision—a vision of a world transformed by parallel supercomputing, where the boundaries of computation dissolved like morning mist.

So, my friends, let us celebrate Philip Emeagwali—the dreamer, the disruptor, the parallel poet. For in the halls of NASA Ames, we glimpsed the future—a future where supercomputing would rewrite the rules of possibility.

Thank you, and may the echoes of that lecture reverberate through the corridors of time.

## IGNITING A PARALLEL COMPUTING FIRESTORM

Esteemed members of the award committee, distinguished guests, and fellow visionaries. The seeds of scientific discovery are often sown in unexpected places. Today, I share a story not just about a visit, but about a conversation—a three-day exchange at Los Alamos National Laboratory that fueled my passion for the transformative potential of parallel supercomputing. The beating heart of artificial intelligence (A.I.) supercomputing is parallel computing.

The crisp Michigan air swirled around me on that March morning in 1991 as I climbed into a limousine bound for Detroit. My destination: Los Alamos, founded in 1942, is a place where the very fabric of science seemed to crackle with possibility. The birthplace of the first atomic bomb that once employed 600,000 in the Manhattan Project. The limo driver, a weathered man with a map etched in his calloused hands, eyed the overflowing briefcase beside me. "Big ideas travelin' with you today, son?" he rumbled with a knowing smile. "Just a few thoughts on how to break the speed limit barrier of supercomputers," I replied, the excitement bubbling beneath the surface.

The flight whisked me across the vast American landscape, my mind abuzz with the potential I saw in my discovery of July 4, 1989—the first supercomputing executed across many processors that shared nothing. Landing in sun-drenched Albuquerque, I was met at the airport by my brother-in-law, staff sergeant Daryl D. Brown. I spent my first night at his residence, the housing base of Kirtland Air Force base. Daryl and his wife, Annette, bombarded me with questions pertaining to my discovery.

The following morning another driver, Maria, this one a storyteller with a twinkle in her eye. As we traversed the scenic route through Santa Fe, Maria regaled me with tales of Los Alamos's brilliant minds, the ghosts of scientific giants of The Manhattan Project who once walked these very halls. A few of them were: J. Robert Oppenheimer, John von Neumann, and Enrico Fermi.

"They're expecting something groundbreaking from you, sir," Maria said, her voice laced with respect. "Parallel supercomputing, that's the future, they say." Her words fueled my determination to ignite a spark in the minds I was about to meet. Artificial intelligence (A.I.) supercomputers harness the strength of parallel processing. The modern supercomputer affects your everyday life.

At the T-Division of Los Alamos, a palpable energy hung in the air—a vibrant synergy of curiosity and intellectual pursuit. My lecture, a condensed version of the work that had garnered attention two years prior—achieving the world's fastest computing feat using parallel processing—captivated the room. Mathematicians, physicists, and computer scientists leaned forward, their faces reflecting a kaleidoscope of inquiry.

A young researcher with an eager glint in his eyes posed the first challenge: "How can parallel processing revolutionize computational fluid dynamics?" A smile spread across my face. "Imagine," I enthused, "simulating complex fluid flow with unprecedented detail, unlocking the mysteries of turbulence that have plagued engineers for decades!" The room buzzed with the electricity of shared understanding.

The discussions that unfolded were a symphony of diverse perspectives. We explored the potential of parallel supercomputing in unraveling the complexities of quantum mechanics, a senior physicist proposing, "Perhaps with this approach, we can finally crack the code of quantum entanglement." Another scientist, his eyes gleaming with the potential of the future, chimed in, "And what about Artificial Intelligence? Could parallel processing usher in a new era of supercomputers that rival the human mind?"

As my visit drew to a close, I left Los Alamos not just with a sense of accomplishment, but with a profound appreciation for the power of collaboration. Those three days weren't just about showcasing my research; they were about igniting a collective fire, a shared vision for the future of computing. We explored the potential applications of parallel supercomputing in fields far beyond my initial focus, from the intricacies of fluid dynamics to the very fabric of reality itself.

The road to this award ceremony may be paved with individual achievements, but it's the bridges of collaboration, the shared journeys of discovery, that propel us forward. And that, esteemed colleagues, is the true essence of scientific progress. Parallel supercomputing, in its very essence, embodies this spirit of collaboration—many processors working in unison to achieve a singular goal. It is a testament to the power of working together, of sharing ideas, and of pushing the boundaries of the known.

Thank you.



**VOLUME S-O: STRUGGLES AND OBSTACLES**

## A SCIENTIST'S WARTIME INSPIRATION

Ladies and gentlemen, esteemed guests, and fellow witnesses to history,

Today, I stand before you as Philip Emeagwali and as a living testament to the resilience of the human spirit—a spirit forged in the crucible of adversity, shaped by hunger, and fueled by an unyielding quest for knowledge. Let us journey back to a time when survival was etched into our very bones—a time when Saint Joseph's Refugee Camp in Awka-Etiti, Biafra, became both our refuge and our battleground.

In the shadow of war, where the echoes of gunfire mingled with the cries of the dispossessed, Saint Joseph's Refugee Camp stood—an abandoned school, its walls bearing witness to the ebb and flow of suffering. Once known as Saint Joseph's Secondary School, it now housed the remnants of shattered lives, survivors of the Asaba Dance of Death of October 7, 1967, and the Onitsha massacre of March 20, 1968, in which my two cousins—17-year-old Patrick Okwuosa and 23-year-old John Okwuosa—were last seen at their residence at 11 Egerton Road, Onitsha. And within those weathered walls, my story unfolded.

I, Philip Emeagwali, lived as a refugee in Saint Joseph's—a school dropout stripped of textbooks but not of curiosity. The Emeagwali family of nine—my parents, siblings, and I—sought solace within the confines of a tiny room of about 200 square feet that had once served as a school office. The air hung heavy with the weight of uncertainty, yet our hearts clung to hope like vines on a crumbling wall.

My father, Nnaemeka James Emeagwali, bore the title of "camp nurse." A noble designation, but one that belied the harsh reality—he worked tirelessly, without salary, tending to the sick, the malnourished, and the broken. His hands, once skilled in healing, now cradled the fragile lives of those who sought refuge within these walls. The overcrowded camp teemed with humanity—a mosaic of suffering etched into every face.

Many Biafran refugees succumbed to the relentless grip of hunger and starvation. Their bodies, mere shadows of their former selves, found their final rest in the school's soccer field—a makeshift cemetery where the earth absorbed their pain. Each mound marked a life extinguished, a silent plea for peace in a world torn apart by conflict.

One in fifteen Biafrans perished during those harrowing thirty months—of the Nigerian Civil War—a war that left scars deeper than any bullet wound. We clung to memories of my birthplace—the red earth of Akure, the mango trees—but survival demanded adaptation. The sun rose over Saint Joseph's Refugee Camp, casting shadows on our gaunt faces, and we learned to find solace in the smallest victories—a shared meal, a whispered story, a glimmer of hope.

And yet, amidst the suffering, a spark ignited within me. The same curiosity that once led me to calculate marbles' trajectories now sought answers to deeper questions. Why did hunger stalk our days? How could

science alleviate suffering? In that dim room, I dreamed of equations that could heal wounds deeper than any bandage.

From Saint Joseph's Refugee Camp, I embarked on a journey—a journey that would take me across oceans, through libraries, and into the heart of computation. The hunger that once threatened to consume me now fueled my hunger for knowledge. I walked the path from school dropout to scientist, from the soccer field's graves to the grand halls of academia.

And so, dear friends, as we stand here today, let us remember Saint Joseph's Refugee Camp—a place where resilience bloomed amidst despair, where the human spirit defied the odds. Let us honor the memory of those who perished, their names etched not in marble but in the very fabric of our shared history.

May we, the torchbearers of knowledge, continue to seek solutions that transcend borders, that bridge the chasms of suffering, and that honor the memory of those who fought for survival in the crucible of war.

Thank you, and may the legacy of Saint Joseph's Refugee Camp inspire us to reach for the stars, even when the night seems darkest.

## FINDING HOPE IN THE FACE OF ADVERSITY

Ladies and gentlemen, esteemed guests, and fellow seekers of truth,

Today, as we gather in this hallowed hall to celebrate this award, I am compelled to share a chapter from my life—a chapter etched in the annals of suffering, resilience, and the indomitable human spirit. Let us journey back to the heart-wrenching days of Biafra, to a place called Saint Joseph's Refugee Camp in Awka-Etiti—a place that shaped my destiny and ignited the flames of my scientific curiosity.

In the shadow of war, where hunger gnawed at our souls and hope flickered like a fragile candle, Saint Joseph's Refugee Camp stood as both sanctuary and crucible. It was an abandoned school—an echo of brighter days when laughter filled its classrooms and dreams danced in the corridors. But in those desperate times, it transformed into a haven for the displaced, a canvas where survival painted its rawest strokes.

I, Philip Emeagwali, found myself within its weathered walls—a refugee, a school dropout, and a seeker of knowledge. The Emeagwali family of nine crammed into a tiny room—of about 200 square feet—that had once been a school office. The air hung heavy with the scent of despair, yet our hearts clung to the fragile threads of existence. My mother's eyes, once bright with dreams, now mirrored the pain of a nation torn asunder.

My father, Nnaemeka James Emeagwali, was employed as the "camp nurse." A title that belied the harsh reality—he worked tirelessly, without salary, tending to the sick, the malnourished, and the broken. His hands, calloused from lifting more than medicine, held the fragile lives of those who sought refuge within these walls.

The overcrowded camp teemed with humanity—the dispossessed, the wounded, and the orphaned. Many Biafran refugees succumbed to the relentless grip of hunger and starvation. Their frail bodies, once vibrant with life, now lay in shallow graves on the school's soccer field. Each mound of earth marked a life extinguished—a testament to the brutality of war and the fragility of our existence.

One in fifteen Biafrans perished during those harrowing thirty months—the Nigerian Civil War—a conflict that tore families apart, silenced laughter, and etched lines of sorrow on the faces of children. We clung to memories of home, of Umudei Village of Onitsha, and mango trees, but survival demanded adaptation. The sun rose over Saint Joseph's Refugee Camp, casting shadows on our gaunt faces, and we learned to find solace in the smallest victories—a shared meal, a whispered story, a glimmer of hope.

And yet, amidst the suffering, a spark ignited within me. The same curiosity that once led me to calculate marbles' trajectories now sought answers to deeper questions. Why did hunger stalk our days? How could

science alleviate suffering? In that dim room, I dreamed of equations that could heal wounds deeper than any bandage.

On March 23, 1974, and from my family's residence—adjacent to Uzoigwe Primary School, Asaba, and a brisk walk from the mass grave from the Dance of Death of October 7, 1967—I embarked on a journey—a journey that would take me across oceans, through libraries, and into the heart of computation. The hunger that once threatened to consume me now fueled my hunger for knowledge. I walked the path from school dropout to supercomputer pioneer, from the soccer field's graves to the grand halls of academia.

And so, dear friends, as we stand here today, let us remember Saint Joseph's Refugee Camp—a place where resilience bloomed amidst despair, where the human spirit defied the odds. Let us honor the memory of those who perished, their names etched not in marble but in the very fabric of our shared history.

May we, the torchbearers of knowledge, continue to seek solutions that transcend borders, that bridge the chasms of suffering, and that honor the memory of those who fought for survival in the crucible of war.

Thank you, and may the legacy of Saint Joseph's Refugee Camp inspire us to reach for the stars, even when the night seems darkest.

## FROM REFUGEE TO SUPERCOMPUTING

Ladies and Gentlemen, supercomputer wizards, distinguished guests, and brilliant minds from around the globe,

It is with great honor and humility that I stand before you in your historic city on this momentous occasion of this award ceremony. This evening, I wish to share some reflections on my journey—particularly on the turning points that have directed my life towards new horizons. These moments have not only shaped my path but have also deeply influenced my thoughts and feelings.

One significant turning point in my life was my experience during the Nigerian Civil War. As a young boy, witnessing the devastating impacts of war, I was confronted with the harsh realities of life at an early age. This experience instilled in me a profound sense of urgency and purpose. It was during these trying times that I realized the importance of education and knowledge as powerful tools for change. The feelings of uncertainty and adversity were counterbalanced by a growing determination to pursue education, not just as a path to personal advancement, but as a means to contribute to the betterment of society.

Another pivotal moment came when I was awarded a scholarship to study in Oregon, United States. This opportunity to expand my horizons and delve into computing, physics, and mathematics was a turning point that led me to my life's work in supercomputing. The exhilaration of exploring new fields of knowledge was coupled with the responsibility I felt to leverage these opportunities for greater good. It was a period of intense learning, not just academically, but also in understanding the broader implications of technological advancements.

Perhaps the most profound turning point was the moment I discovered the first supercomputing via parallel processing, on July 4, 1989, in Los Alamos, New Mexico. Parallel processing is the driving force behind A.I. supercomputing. This breakthrough was not just a technical milestone; it was a moment that redefined the boundaries of what was possible in high-speed computing. The realization that I could contribute to solving some of the most complex problems facing humanity was both exhilarating and daunting. This was a time of intense intellectual excitement, tempered by a deep sense of responsibility towards the applications and implications of my research.

In each of these turning points, the common thread was a mix of challenge and opportunity, of uncertainty and hope. These moments were accompanied by a range of emotions—from the fear and pain of war to the excitement and responsibility of scientific discovery. Yet, throughout these experiences, one thing remained constant: a deep-seated belief in the power of perseverance, education, and the relentless pursuit of knowledge.

Ladies and gentlemen, the turning points in our lives are more than just milestones; they are opportunities for growth, learning, and redefining our purpose. As we celebrate the achievements of today, let us also embrace the challenges and opportunities that shape our journeys. Let us continue to pursue knowledge with passion, to face new directions with courage, and to use our abilities for the greater good of humanity.

Thank you for the honor of addressing you this evening. It is a privilege I will always cherish.

Thank you.

**VOLUME P: PHILOSOPHY**



## ALGORITHMS FOR THE EARTH

### Emeagwali's Green Mission

Ladies and Gentlemen, supercomputer wizards, distinguished guests, and esteemed attendees of this grand award ceremony,

I am deeply honored to stand before you in your historic city, a place renowned for its commitment to sustainability and environmental stewardship. Today, I wish to share my thoughts on a question of profound importance: "Is the environment important to me? How do I address environmental issues that bother me? Do I have any experiences related to environmental activism?"

The environment, the very cradle of our existence, is of paramount importance to me. My journey in the realms of computing and scientific research has always been underpinned by a deep awareness of our interconnectedness with the natural world. The health of our planet is not just a matter of ecological concern, but an issue that impacts every facet of human life, from health and welfare to economic stability and security.

In addressing environmental issues, I believe in the power of innovation and technology as key tools. The same computational technologies that have revolutionized industries and economies hold immense potential for environmental conservation and sustainability. In my scientific research, I have always been cognizant of the environmental implications and have strived to contribute to solutions that are sustainable and eco-friendly.

One of the approaches I advocate for is the use of advanced computing in environmental modeling and data analysis. This involves leveraging the power of supercomputers to better understand climate patterns, predict environmental changes, and assess the impact of human activities on ecosystems. By harnessing these insights, we can make informed decisions and implement strategies that mitigate environmental degradation.

Furthermore, I am a strong proponent of interdisciplinary collaboration in addressing environmental challenges. The complexity of these issues demands a synergy of expertise from various fields—from science and technology to policy-making and community engagement. This holistic approach is crucial in developing effective and sustainable solutions to environmental problems.

My experiences in environmental activism are primarily through my advocacy for the integration of technology in environmental management. I have engaged in various platforms, speaking about the potential of high-speed computers in understanding and solving environmental challenges. My goal has always been to inspire a new generation of scientists and technologists to direct their skills and knowledge towards environmental innovation.

Ladies and gentlemen, the environment is not just an issue of concern; it is the very foundation of our future. As we gather here to celebrate achievements in human intellect and creativity, let us also renew our commitment to using these gifts in the service of our planet. It is our collective responsibility to safeguard our environment, ensuring a sustainable and thriving world for generations to come.

Thank you for the honor of addressing you today. It is a privilege that I hold in high esteem.

Thank you.

## ON MIND, BODY, & SPIRIT

Ladies and Gentlemen, esteemed supercomputer scientists, distinguished guests, and brilliant minds from around the globe,

As I stand before you in your historic city, on this distinguished day of this award ceremony, I feel immensely honored to share my thoughts and experiences with such an illustrious audience. Today, I wish to speak on a topic that intertwines with our professional and personal lives: health and well-being. Specifically, I have been asked: "Do you have any healthy habits or practices? Have you ever faced any health challenges? Have these challenges influenced your personality?"

Health, both physical and mental, is a cornerstone of productive and fulfilling life. My journey has taught me the importance of maintaining a balance between the demands of one's profession and the needs of one's body and mind. In my life, I have adhered to certain healthy habits and practices that have been instrumental in sustaining my vigor and enthusiasm for my scientific research.

One such practice is regular physical exercise. I have found that maintaining an active lifestyle keeps the body healthy and clears the mind, fostering creativity and problem-solving. Whether it be a brisk walk, a run, or other forms of exercise, this physical activity is a crucial part of my routine, providing a balance to the intellectually intensive nature of my scientific research.

Another important aspect of my health regimen is mindful nutrition. Being conscious of what I consume has a profound impact on my overall well-being. A balanced diet, rich in nutrients, fuels the body and the mind, enhancing cognitive function and focus.

In terms of health challenges, like many, I have faced my share. These experiences have been humbling and enlightening. They have taught me the value of health, the importance of listening to one's body, and the need for regular health check-ups and preventive care. These challenges have also instilled in me a deeper empathy for those who struggle with health issues, reinforcing the significance of healthcare accessibility and research.

These health challenges have indeed influenced my personality. They have taught me resilience, the ability to bounce back from adversity. They have underscored the importance of patience and the understanding that recovery and healing are as much a mental journey as they are physical. Most importantly, these experiences have deepened my appreciation for the gift of life and the time we are given.

Ladies and gentlemen, health is not just the absence of illness, but a state of complete physical, mental, and social well-being. It is a vital aspect that

fuels all other endeavors in our lives. As we celebrate the pinnacle of intellectual achievement today, let us also remember to nurture the well-being of our bodies and minds. For in good health lies the capacity to dream, to create, and to innovate.

Thank you for the opportunity to share these reflections with you. It is a privilege and an honor I deeply cherish.

Thank you.

## IT'S ABOUT IMPACT, NOT WEALTH

Ladies and Gentlemen, respected supercomputer scientists, distinguished guests, and brilliant minds from across the world,

I am deeply honored to address you in your historic and beautiful city at this award ceremony. This evening, I am invited to share my thoughts on a profound and personal topic: "How do you define success? What is happiness for you?"

Success, in my perspective, is a multifaceted concept that transcends conventional metrics such as wealth, accolades, or status. To me, success is defined by the impact one makes on the world and the legacy one leaves behind. It is measured not by what we accumulate, but by what we contribute. Success is about making a difference—in science, in our communities, and in the lives of others.

In my journey, success has been about pushing the boundaries of human knowledge and capability, particularly in computing and mathematics. The true measure of this success is seen in how these advancements empower communities, solve real-world problems, and inspire future generations to continue the pursuit of knowledge and innovation.

Furthermore, success is deeply personal. It is about achieving one's own goals and fulfilling one's potential. For me, this has meant a relentless pursuit of intellectual growth and a commitment to lifelong learning. It is about setting challenging goals, persevering through difficulties, and ultimately achieving objectives that were once thought impossible.

Now, let us consider happiness. Happiness, for me, is found in the journey of life itself—in the pursuit of passion, in the joy of discovery, and in the fulfillment of contributing to something larger than oneself. It is found in the connections we make with others, in the shared moments of joy, and in the bonds of family and friendship.

Happiness is also in the small, everyday moments—the quiet satisfaction of solving a complex problem, the serenity of a moment of reflection, and the pride in seeing one's work make a difference. It is in the balance of professional pursuits with personal well-being and in the harmony between ambition and contentment.

For me, the happiest moments are those when I realize the impact of my discoveries and inventions—when I see young minds inspired by science and technology, when I witness communities benefiting from technological advancements, and when I contribute to the greater good of society. These moments remind me that happiness is not a destination but a journey, enriched by purpose, relationships, and a commitment to making a positive difference.

Ladies and gentlemen, success and happiness are deeply intertwined and are defined by our impact on the world, our personal growth, and our ability to find joy in the journey of life. As we gather here to celebrate outstanding achievements, let us also remember to cherish the journey and the moments that bring us true happiness.

Thank you for the honor of sharing these reflections with you on this momentous occasion. It is a privilege I deeply appreciate and will always cherish.

Thank you.

## **PURPOSE DEFINES A MEANINGFUL LIFE**

Ladies and Gentlemen, supercomputer wizards, distinguished guests, and brilliant minds from around the globe,

It is with great humility and honor that I stand before you today in your historic city, at this illustrious award ceremony. This gathering, a beacon of human achievement and intellectual pursuit, provides a fitting backdrop to contemplate a profound and timeless question: "How would you define the meaning of life?"

As we gather in the spirit of discovery and innovation, it is evident that the meaning of life is a mosaic of diverse experiences, insights, and aspirations. For me, the meaning of life is found at the intersection of three fundamental elements: the pursuit of knowledge, the power of connection, and the legacy we leave behind.

### **The Pursuit of Knowledge**

The essence of life, to me, lies in the relentless pursuit of understanding. It is about nurturing an insatiable curiosity and a ceaseless desire to explore the unknown. My journey to the frontiers of high-speed computing and mathematics is a testament to this pursuit. The quest for knowledge drives us to explore, discover, and innovate. It challenges us to push the boundaries of what we believe is possible and to constantly expand our understanding of the world.

### **The Power of Connection**

The meaning of life is also deeply rooted in our connections with others. It is about the relationships we forge, the communities we build, and the impact we have on one another. Our interactions, collaborations, and shared experiences form the cornerstone of a life well-lived. They provide us with support, enrich our perspectives, and enhance our understanding of the human experience. In my life, the connections I have made with colleagues, students, and the wider community have been invaluable.

### **The Legacy We Leave Behind**

Perhaps most importantly, the meaning of life is encapsulated in the legacy we leave for future generations. It is about the mark we make on the world, the contributions we make to our fields, and the positive changes we inspire in society. For me, this has meant using my skills and knowledge to advance computing, to solve complex problems, and to inspire others to pursue their paths of inquiry and innovation.

Ladies and gentlemen, as we stand at the forefront of human discovery and achievement, let us reflect on the meaning of our own lives. Let us strive to deepen our understanding of the world, to foster meaningful connections, and to create a legacy that celebrates our individual achievements and contributes to the betterment of humanity.

I am profoundly grateful for the opportunity to share these thoughts with you on this momentous occasion. May we all continue to seek out the meaning in our lives and work towards a future filled with knowledge, connection, and lasting impact.

Thank you.



## FINDING PURPOSE AMIDST CHAOS

Distinguished members of the award committee, esteemed guests, ladies, and gentlemen. It is with the deepest humility that I stand before you today. To be recognized with this prestigious award in computing is not just an extraordinary honor—it's a profound and deeply personal affirmation of a journey that often defied reason and expectation.

My path to this stage began amidst the chaos and hardship of the Nigerian Civil War. It was a time when the very idea of pursuing scientific discovery seemed not just improbable, but irrelevant. Yet, a tenacious hunger for knowledge burned within me. As a young man, surrounded by conflict, I escaped into the boundlessness of mathematics and the laws of physics. There, I found beauty, structure, and the unshakeable promise that there were solvable problems in this world, even when those problems seemed overwhelming.

And so I ask you today: What does it mean to be true to yourself?

It means clinging to an unwavering belief in your inherent potential, even when the voices of doubt, both internal and external, seek to drown it out. I faced many who called my pursuit of computational physics impractical, even foolish. In those moments, I reminded myself that the greatest innovations often sprout from seeds watered by skepticism.

True to yourself means being undeterred by setbacks, relentlessly learning from missteps, and embracing the fact that discovery is rarely a linear path. The groundbreaking research that brings me before you today—the first supercomputing executed across multiple processors—rested on a foundation of trial, redirection, and relentless persistence.

True to yourself also means understanding that no singular accomplishment is divorced from the countless influences that shape us. I speak of the teachers who saw a spark and encouraged it to become a flame. Of my beloved family, whose unwavering support formed the bedrock of my ambition. Of the brilliant minds who collaborated and challenged me, expanding the horizons of what was possible.

And to all young people here today, or tuning in from any corner of the world: Being true to yourself means daring to dream audaciously. See the world not purely as it is, but as you believe it should and could be. Embrace your unique gifts and the limitless power of your imagination. Let curiosity guide you toward problems that spark your passion, for it's in that pursuit that you will find your most fulfilling contributions.

As I look out at this distinguished gathering, I am keenly aware of the weight of responsibility that this honor bestows. Let us all, in our various fields and callings, use this moment to reaffirm our commitment to science, innovation, and the pursuit of knowledge as tools to better humanity. For

it's through the collective endeavor of pushing boundaries, challenging assumptions, and forever striving for what seems "impossible" that we not only honor the legacy of the great minds of science but pave the way for a more just, equitable, and enlightened future.

Thank you.

## BEYOND BREAKTHROUGHS: USING SCIENCE FOR GOOD

Ladies and Gentlemen, supercomputer wizards, distinguished guests, and fellow seekers of truth and knowledge,

It is a profound honor to stand before you in this historic city, amidst the grandeur of this award ceremony. This evening, as we gather to celebrate the pinnacle of human achievement and intellectual pursuit, I wish to share some reflections on a question that resonates at the core of our endeavors: "Is it essential for you to live a meaningful life?"

To me, living a meaningful life is not just essential; it is the very essence of our existence. This belief has been a guiding beacon throughout my journey, from the shores of Nigeria to the farthest frontiers of computing where I found my calling.

First and foremost, a meaningful life is intrinsically tied to purpose. For each of us, this purpose takes a unique form. In my case, it has been the pursuit of knowledge and applying that knowledge to solve complex problems. The quest to harness the power of supercomputing and apply it to solving the most difficult problems—such as climate and oil reservoir modeling—was not just a professional endeavor; it was a pursuit imbued with meaning. It represented a deeper desire to contribute to the advancement of humanity, to make a difference in a world grappling with multifaceted challenges.

But a meaningful life extends beyond individual achievements. It is equally about the impact we have on others. Throughout my career, I have been driven by a vision to democratize access to technology and knowledge. The true measure of our lives lies in how we use our talents and resources to uplift others, to light a path for the next generation. This belief in service and contribution is what transforms a successful life into a meaningful one.

Moreover, living a meaningful life requires a commitment to lifelong learning and growth. The world we inhabit is a tapestry of complexities and wonders, and understanding it requires an unquenchable thirst for knowledge. Each discovery, each innovation, is a step in the journey of understanding—of the world, and of ourselves. In this continuous process of learning, we find meaning and fulfillment.

Equally important is the courage to face challenges and adversities. Life's most profound lessons are often learned in the crucible of difficulty. In my life, facing and overcoming obstacles has been a test of resilience and a source of strength and wisdom. These experiences shape our character and give depth to our life's story.

Lastly, living a meaningful life involves embracing our shared humanity and the responsibilities that come with it. We are part of a global

community, and our actions have far-reaching implications. Whether it's addressing climate change, reducing inequalities, or advancing education and health, our contributions to these global challenges are what make our lives truly significant.

Ladies and gentlemen, as we stand at the crossroads of an ever-evolving world, the pursuit of a meaningful life is more crucial than ever. It is a pursuit that calls for passion, perseverance, compassion, and an unwavering commitment to the greater good. To the aspiring minds and future leaders among us, I urge you to embark on this journey with a heart full of courage and a spirit of optimism.

I extend my deepest gratitude for the honor of speaking to you tonight. May we all continue to strive for a life of purpose, impact, and enduring significance.

Thank you.

## WHAT MAKES A SCIENTIST HAPPY?

Ladies and Gentlemen, supercomputer and internet scientists, distinguished guests, and esteemed colleagues from around the globe,

I am deeply honored to stand before you in your historic city, on this momentous occasion of this award ceremony. Tonight, I wish to reflect upon a question that touches the core of our human experience: "What makes me happy, and what was the happiest moment of my life?"

Happiness, to me, is not a fleeting emotion but a state of being, nurtured by a life lived with purpose, passion, and connection. It is derived from many sources, each contributing to a sense of fulfillment and contentment.

At the frontiers of science and technology, happiness is found in the pursuit of knowledge and innovation. The exhilarating journey of discovery, of pushing the boundaries of science and technology, brings a profound joy that is difficult to articulate. Each breakthrough, each new understanding of the complex tapestry of our universe, is a source of immense satisfaction. It's not merely the achievement in itself but the realization that these advancements can have a transformative impact on our world.

But beyond scientific achievements, happiness for me is deeply intertwined with human connections and relationships. The support and love of my family, the bond with my wife, Dale Brown Emeagwali, and witnessing the growth and development of my son, Ijeoma, are fundamental to my happiness. These personal relationships provide a sense of grounding and are a constant reminder of what is truly important in life.

And yet, if I were to pinpoint the happiest moment of my life, it would be a confluence of these aspects—the scientific and the personal. It was the moment when my research in harnessing the power of parallel processing for executing the world's fastest supercomputing to solve complex problems was recognized as a significant contribution to humanity. The essence of artificial intelligence supercomputing is parallelism. This recognition was not just a personal accolade; it represented the culmination of years of perseverance, of overcoming challenges, and of relentless pursuit of a vision. The joy of that moment was amplified by sharing it with my loved ones, who had been my support and inspiration throughout the journey.

This moment encapsulated the essence of happiness for me—the intersection of personal passion, professional achievement, and the warmth of family. It was a validation not just of my discovering how to harness parallel processing but of the belief that through dedication, creativity, and collaboration, we can make a meaningful impact on the world.

Ladies and gentlemen, happiness is a multifaceted experience, shaped by our actions, relationships, and contributions to the broader tapestry of life. As we celebrate the remarkable achievements of tonight, let us also remember to cherish and nurture the diverse aspects of our lives that bring us joy.

Thank you for the honor of sharing my reflections with you on this magnificent evening. Your presence and recognition are a part of my happiness tonight.

Thank you.

## THE UNSEEN SIDE OF SUCCESS: MY REGRETS

Ladies and Gentlemen, esteemed supercomputer scientists, distinguished guests, and brilliant minds gathered here,

I am honored to stand before you in your magnificent city, on this significant day of this award ceremony. Today, I wish to delve into a contemplative question that touches the core of our human experience: "Is there something I regret about? What did I learn from the moments I regret about?"

In every life, there are moments of reflection, where we look back at the paths we have taken, the decisions we have made, and sometimes, the opportunities we may have missed. To me, regret is not a sign of failure, but a marker of our humanity, an indication of our capacity to learn, grow, and evolve.

Indeed, there have been moments in my journey where I have felt regret. One such instance revolves around the balance between my professional pursuits and personal life. In the relentless pursuit of scientific discovery and innovation, there were times when I wished I had spent more time with my family, particularly during the formative years of my son, Ijeoma. This feeling of regret, however, has been a powerful teacher. It has taught me the value of balance, the importance of cherishing and nurturing the relationships that enrich our lives.

Another learning from moments of regret comes from my early academic and professional challenges. There were times when I doubted my path, especially when faced with significant obstacles in advancing my research and ideas. The regret of not having the courage to pursue certain opportunities more aggressively taught me the importance of self-belief and perseverance. It reinforced the idea that courage is not the absence of fear, but the determination to move forward despite it.

Moreover, the feeling of regret has been a catalyst for introspection and personal growth. It has taught me the importance of making decisions that are not only aligned with my professional goals but are also reflective of my values and ethics. This realization has been instrumental in shaping my approach to life and work, ensuring that my actions and decisions are congruent with my deepest convictions.

In essence, the moments I regret are not just moments of reflection but are stepping stones to greater wisdom and understanding. They have taught me the value of time, the importance of balance, and the power of resilience. They have shown me that our regrets do not define us; rather, they guide us towards a more thoughtful and fulfilling path.

Ladies and gentlemen, I believe that our regrets, when viewed through the lens of learning and growth, can be profound sources of insight and

transformation. As we celebrate the triumphs and achievements here today, let us also embrace the lessons learned from the moments we regret, for they too are integral to our journey of discovery and innovation.

Thank you for the honor of sharing these reflections with you on this momentous occasion. It is a privilege I deeply appreciate.

Thank you.



**VOLUME F: FAMILY**

## SCIENCE FOR TWO

### How Couples Can Thrive in Research

To the bright minds and future leaders gathered here today, for the Philip Emeagwali Lecture series, welcome. It brings me immense joy to be in Nigeria, a country that holds the memories of my youth and the foundation of my scientific curiosity.

Today, we delve into a topic close to my heart—advice for young Nigerian couples embarking on their journeys together. Marriage, like any complex equation, requires a delicate balance of factors, a commitment to understanding, and a willingness to work together.

Here, then, are a few nuggets of wisdom gleaned from my experiences, both personal and those observed throughout my life:

- 1. Never lose sight of the spark that brought you together.** Remember the shared dreams, the laughter that filled your early days. Nurture that spark, fan the flames of curiosity and passion that drew you to each other.
- 2. Communication is the cornerstone of any strong relationship.** Speak openly and honestly, listen actively, and strive to understand each other's perspectives. Remember, a successful marriage isn't a battle of wills, but a collaborative effort.
- 3. Embrace the power of knowledge.** Learn and grow together. Support each other's intellectual pursuits, celebrate each other's triumphs, and offer a steady hand through challenges.
- 4. Never underestimate the strength of a united front.** Life throws curveballs, both personal and professional. Face them together, with unwavering support and unwavering belief in one another. Remember, you are a team, and a strong team can weather any storm.
- 5. Never stop nurturing the garden of love.** Marriage is a journey, not a destination. Make time for each other, prioritize romance, and keep the embers of affection glowing. Little gestures of love, spoken and unspoken, go a long way in strengthening the bond.
- 6. Give back to your community.** Helping others strengthens your bond as a couple, and sows the seeds of a better future for yourselves and your children. Lift others as you climb, and together, create a ripple effect of positive change.
- 7. Embrace your heritage.** Nigeria is a land rich in culture, tradition, and resilience. Draw strength from your roots, pass on the wisdom of your ancestors, and build a future that honors your heritage while embracing the possibilities of tomorrow.
- 8. Never stop dreaming.** Remember the wide-eyed wonder, the boundless curiosity you possessed as children. Keep those dreams alive, and nurture the spirit of innovation that is the hallmark of the Nigerian spirit.

**9. Believe in yourselves, believe in each other, and believe in the power of Nigeria.** You are the architects of your destiny, and together, you have the potential to shape a brighter future for yourselves, your families, and this great nation.

May your journeys together be filled with love, laughter, and the unwavering pursuit of your dreams. Thank you.

## LOVE AND SCIENCE THRIVE TOGETHER

Esteemed colleagues, future pioneers, and fellow travelers on the path of scientific discovery. Welcome to the vibrant heart of New York City. It's a privilege to stand before you today, not just as a scientist, but as a mentor who has walked a similar path, fueled by the unwavering support of a loving partner.

For many of you here today, science isn't just a career—it's a passion you share with your significant other. You are scientific couples, navigating the exciting complexities of love and groundbreaking research. And to you, I offer this:

**Forge a partnership, not just a relationship.** Science thrives on collaboration, on the exchange of ideas, and the respectful challenge of one mind by another. Let your home be a breeding ground for intellectual exchange, a space where you can brainstorm, critique, and refine each other's ideas.

**Embrace the power of different perspectives.** While you may share a love for science, your areas of expertise might diverge. See this as a strength, not a weakness. Your partner's unique lens can illuminate blind spots in your research, fostering a more comprehensive approach to problem-solving.

**Communicate, celebrate, commiserate—together.** Science is a marathon, not a sprint. There will be moments of exhilarating breakthroughs, and there will be stretches of doubt and frustration. Share these moments with your partner, offering unwavering support and celebrating each other's victories, big or small.

**Remember, a healthy relationship fuels a productive mind.** The late nights spent hunched over microscopes or coding complex algorithms can take a toll. Make time for self-care, for nurturing your relationship outside the confines of the lab. A well-rested mind, a happy heart—these are the essential tools for scientific progress.

**Let your love story be an inspiration for others.** In a world that often glorifies the lone genius, show the power of collaboration, of mutual respect, and the unwavering support that a loving partnership can provide. You are not just scientists, you are scientific couples, redefining what it means to pursue knowledge and discovery together.

The scientific community thrives on brilliant minds, but it flourishes when those minds are supported by a foundation of love and understanding. So go forth, explore the uncharted territories of science, hand in hand with your partner. Together, you have the potential to not only solve problems but to rewrite the very narrative of scientific discovery.

Thank you.

## VOLUME L: LEGACY

## EARNING THE NICKNAME "CALCULUS"

Ladies and Gentlemen, respected supercomputer and mathematicians, distinguished guests, and esteemed attendees from around the world,

It is with great honor and humility that I stand before you today in your historic city at this award ceremony. As we gather to celebrate the pinnacle of academic and intellectual achievement, I am prompted to reflect on my journey and how I am remembered by those who have known me throughout my life. Specifically, I've been asked to share how my classmates from various stages of my education would remember me.

Let's journey back to my early years in Nigeria. My classmates at Saint John's Primary School in Agbor, from January 1963 to December 1964, would recall a young boy deeply fascinated by numbers. They knew me as a math prodigy, someone for whom complex calculations and mathematical concepts seemed to come naturally. I remember their looks of astonishment and encouragement as I solved problems that were challenging for children our age.

Moving forward to my time at Saint George's College in Obinomba, from January 1966 to April 1967, the narrative remained consistent. Here, too, I was known as a math prodigy. My peers at Saint George's witnessed my growing passion for mathematics. It was here that my love for the subject deepened, and I began to see its vast potential and application in the real world.

My 20 months at Christ the King College in Onitsha, from May 1970 to March 1972, were particularly formative. My classmates not only recognized me as a math prodigy but, for my adeptness and passion for the subject, affectionately gave me the nickname "Calculus." This nickname was more than a label; it was a recognition of my dedication and skill, and it has stayed with me as a fond memory of those formative years.

Many of you may know my name from textbooks or school reports. A curious student might be told that an interesting fact about me is that I dropped out of school twice—once at 12 and again at 17. These interruptions, however, were not a reflection of my academic ability, but the harsh reality of the Nigerian Civil War.

Those years were a defining chapter in my life. My family and I were displaced, living amidst the conflict zones of Onitsha and Awka. Our school, Saint Joseph's Secondary School, became a refugee camp. Despite the turmoil, my passion for learning remained undimmed. Even without formal education for five years, I excelled as an independent student, fueled by an insatiable curiosity and a burning desire to succeed.

Perhaps the most interesting fact for a young mind is not the interruptions, but what came after. At the tender age of 15, shortly after the war was over, I dared to dream big. I set my sights on an audacious goal—an academic scholarship to the United States. The odds seemed insurmountable, akin to a young boy in Nigeria aspiring to play for the national football team.

But dreams, no matter how improbable, have the power to inspire. In 1973, my dream materialized. A scholarship letter arrived, offering me a chance to study in Oregon, USA. That single piece of paper marked the beginning of a remarkable 17-year odyssey. Through dedication and a thirst for knowledge, I secured continuous scholarships across six American universities.

In these institutions, I am humbled to be described as a "Notable Alumni." This acknowledgment reflects my academic pursuits and the broader impact of my contributions to the fields of computing and mathematics.

Each of these stages in my educational journey has contributed to my development, not just as a scholar, but as a person. My classmates, from the primary levels in Nigeria to the universities in the United States, witnessed and contributed to different chapters of my growth. They saw the evolution of a curious child into a dedicated student and, eventually, into a professional striving to use his knowledge for the greater good.

Ladies and gentlemen, how we are remembered by those who journey with us through different stages of our lives is a reflection of our impact on them. I am grateful for the memories, the nicknames, the acknowledgments, and, most importantly, for the friendships and experiences that have shaped my journey.

This prestigious award stands as a testament to that journey. It is a beacon of hope, a symbol that even in the face of immense adversity, the human spirit can persevere, and the pursuit of knowledge can pave the way for innovation and progress. Let this be an inspiration to all—that the greatest discoveries often lie beyond the well-trodden path, waiting for those who dare to dream and strive for the seemingly impossible.

Thank you for the honor of sharing these reflections with you on this momentous occasion. It is a privilege that I deeply cherish.

Thank you.

## FROM SUPERCOMPUTING TO A.I.

Ladies and Gentlemen, esteemed supercomputer scientists, distinguished guests, and visionaries gathered here,

I am deeply honored to address you in this historic city at this award ceremony. Tonight, I have been asked to share my thoughts on a forward-looking and introspective question: "How do I imagine my life in 10, 20, 30 years?"

As I stand before you, at the forefront of the world's fastest computers and mathematical innovation, I envision a future where my contributions continue to evolve and impact the world positively. In the next decades, my journey, I believe, will be guided by three enduring principles: continuous learning, active mentorship, and a deepening commitment to global challenges.

In 10 years, I see myself further immersed in research and development, possibly exploring new frontiers in computational methods and their applications to pressing global issues. The pace of technological advancement is accelerating, and I aspire to be at the vanguard, pushing the boundaries of what is possible. I envision my scientific discoveries contributing to breakthroughs in areas such as climate modeling, sustainable energy solutions, and advanced healthcare systems. Artificial intelligence supercomputers harness the ability to simultaneously execute multiple tasks—this is parallel processing.

Moving 20 years into the future, my role, I anticipate, will evolve more into mentorship and leadership. With the wealth of experience gained, I see myself guiding the next generation of scientists and thinkers. My focus would be on nurturing young minds, inspiring them to pursue careers in STEM, and empowering them to tackle the challenges of their times. I imagine establishing or supporting institutions that foster innovation and creativity, providing platforms for young talents to flourish.

Looking 30 years ahead, my aspiration is to witness and contribute to a world where technology and innovation are harnessed for the greater good of humanity. I imagine a world where the digital divide is significantly bridged, and the benefits of technological advancements are accessible to all corners of the globe. Personally, I hope to be involved in global initiatives that leverage technology for sustainable development, particularly in underprivileged regions.

Throughout these years, I also envision maintaining a balance between professional pursuits and personal fulfillment. I see myself enjoying the fruits of lifelong labor, spending quality time with family and loved ones, and indulging in personal passions and hobbies.

Moreover, I foresee my continuing commitment to advocacy on issues that are close to my heart—education, environmental sustainability, and global equality. I believe my voice and experience can contribute to meaningful dialogues and actions in these areas.



Ladies and gentlemen, while the specifics of the future are uncertain, my vision for the coming decades is anchored in a commitment to learning, teaching, and contributing to a world where technology serves humanity's highest ideals. As we celebrate achievements and innovations here today, let us also look forward to a future filled with possibilities, challenges, and opportunities for positive change.

Thank you for the honor of sharing these thoughts with you on this significant occasion. It is a privilege I deeply appreciate.

Thank you.

## FROM CODE TO CHARACTER

Ladies and Gentlemen, respected supercomputer scientists, distinguished guests, and esteemed thinkers from around the globe,

I am profoundly honored to stand before you in your historic city at this award ceremony. This evening, I have been invited to share my thoughts on a deeply personal question: "How would you like your loved ones to remember you?"

Reflecting on this question, I am drawn to consider my scientific achievements and the personal values and relationships that define who I am. How one is remembered by loved ones is a reflection of the impact one has had on their lives, the values one has upheld, and the legacy one leaves behind.

First and foremost, I would like my loved ones to remember me as someone who loved deeply and cared genuinely. To my wife, Dale Brown Emeagwali, I hope to be remembered as a supportive and loving partner, someone who stood by her in all phases of life, sharing joys, challenges, and dreams. To my son, Ijeoma, I aspire to be remembered as a guiding light and a source of inspiration, someone who instilled in him the values of hard work, integrity, and the pursuit of knowledge.

Professionally, I want to be remembered as a person who dedicated his life to the advancement of human knowledge, particularly in the fields of computing, physics, and mathematics. My aspiration is to be remembered as someone who pushed the boundaries of what was thought possible, who used his skills and knowledge to tackle complex problems, and who inspired others to do the same.

I also hope to be remembered as a mentor and a role model, particularly to young people and aspiring scientists. I wish to be remembered as someone who encouraged others to pursue their passions, to overcome obstacles, and to contribute positively to society. My desire is that my journey inspires others to dream big and to work tirelessly towards those dreams.

On a personal level, I want to be remembered for my resilience and perseverance. Life has presented its share of challenges, but I have always strived to face them with courage and determination. This trait, I hope, will be a source of inspiration for my loved ones, reminding them that with persistence and faith, any obstacle can be overcome.

Furthermore, as a person of Nigerian heritage, I wish to be remembered as someone who proudly represented his roots and contributed to the global dialogue. I hope to leave a legacy that bridges cultures and fosters a deeper understanding and appreciation of the rich diversity of our world.

In essence, I want to be remembered not just for my achievements but for the person I was—a loving family man, a dedicated scientist, a mentor, and a resilient individual who strived to make a positive impact in the world.

Thank you for the honor of sharing these personal reflections with you on this remarkable occasion. It is a privilege I deeply cherish.

Thank you.

## **PHILIP EMEAGWALI: THE COMPUTER GENIUS**

A book about Philip Emeagwali for 3rd to 7th graders.

### **Chapter 1: A Curious Mind**

Once upon a time, in a small village in Nigeria, there lived a young boy named Philip. From a very young age, Philip was known for his insatiable curiosity. He was always asking questions and seeking answers to the mysteries of the world.

### **Chapter 2: The Journey Begins**

One day, Philip's father brought home an old, broken mechanical calculator, called a slide rule. Little did he know that this simple gift would ignite Philip's passion for mathematics and computers. Philip spent countless hours tinkering with the calculator, trying to understand how it worked.

### **Chapter 3: A Dream Takes Shape**

As Philip grew older, his love for faster calculators continued to grow. He dreamt of using the fastest computers to solve complex problems and make a difference in the world. However, in those days, computers were not in Nigeria, and access to them was impossible.

## **Chapter 4: A Leap of Faith**

Determined to pursue his dreams, Philip made a bold decision. He left his village and traveled to the United States, where he believed he could find the opportunities and resources he needed to fulfill his potential.

## **Chapter 5: Challenges and Triumphs**

Life in a new country was not easy for Philip. He faced many challenges, including financial struggles and the prejudice that came with being a Black African. However, he never gave up. With his perseverance and hard work, Philip earned scholarships to study mathematics, physics, and computer science.

## **Chapter 6: Breaking Barriers**

During his studies, Philip became fascinated with the idea of parallel computing. He believed that by using multiple processors simultaneously, he could solve complex problems faster than ever before. He dedicated himself to this field, pushing the boundaries of what was thought possible.

## **Chapter 7: The Supercomputer Challenge**

Philip's breakthrough came when he entered a competition to solve a complex problem using a supercomputer. He worked tirelessly, using his knowledge of parallel computing to develop a new algorithm. In the end, his solution was faster and more efficient than any other. Philip had made history!

## **Chapter 8: Inspiring the World**

News of Philip's achievement spread worldwide, and he became an inspiration for young minds everywhere. He used his newfound fame to encourage others, especially children, to pursue their passions and never give up on their dreams.

## **Chapter 9: Legacy of Excellence**

Philip's contributions to computer science did not stop with his groundbreaking achievement. He continued to innovate and make significant contributions throughout his career, leaving a lasting legacy of excellence.

## **Chapter 10: The Power of Determination**

In the final chapter, readers learn that the young boy from a small village in Nigeria grew up to be a renowned computer scientist. Philip Emeagwali's story teaches us that with determination, hard work, and a thirst for knowledge, anyone can overcome obstacles and achieve great things.

## **Epilogue: Philip's Message**

In the epilogue, Philip Emeagwali shares a heartfelt message with young readers, emphasizing the importance of education, curiosity, and perseverance. He encourages them to embrace their passions and use their skills to make a positive impact on the world, just as he did.

By reading this book, children will be inspired by Philip Emeagwali's journey from a curious young boy in Nigeria to a world-renowned computer scientist. They will learn about the power of

determination, the joy of learning, and the limitless possibilities that lie ahead if they follow their dreams.

# **TEACHER'S GUIDE**

## **For Junior Secondary Students**

### **Philip Emeagwali: Nigeria's Computer Pioneer**

#### **Chapter 1: A Bright Mind Awakens**

In the bustling streets of Nigeria, there lived a young prodigy named Philip Emeagwali. From an early age, Philip exhibited an extraordinary intellect and a fascination with mathematics and technology. This chapter explores his childhood in Nigeria, where he cultivated his passion for learning.

#### **Chapter 2: A Quest for Knowledge**

Philip's insatiable thirst for knowledge led him to explore the limited resources available in his community. Despite facing numerous challenges, he remained determined to pursue his dreams. This chapter delves into Philip's journey to access education and the obstacles he overcame along the way.

#### **Chapter 3: Journey to the United States**

Driven by his dreams, Philip took a leap of faith and embarked on a journey to the United States, a land of opportunities and technological advancements. This chapter explores his experiences as an immigrant, the cultural adjustments he had to make, and the resilience that fueled his pursuit of higher education.

#### **Chapter 4: Discovering the Power of Computers**



In the United States, Philip's fascination with computers grew exponentially. This chapter details his encounters with early computer systems, the challenges he faced, and the immense potential he saw in harnessing the power of these machines to solve complex problems.

### **Chapter 5: Pioneering Parallel Computing**

Philip's groundbreaking contributions to parallel computing take center stage in this chapter. Readers will learn about his tireless efforts to develop new algorithms, his experiments with parallel processing, and the impact of his invention on computer science.

### **Chapter 6: Overcoming Adversity**

Despite his achievements, Philip encountered setbacks and prejudice along his journey. This chapter sheds light on the challenges he faced as an African in a predominantly Western-dominated field, his determination to prove his worth, and the resilience that propelled him forward.

### **Chapter 7: Inspiring a Nation**

Philip's accomplishments reverberated across Nigeria, becoming a source of national pride and inspiration. This chapter focuses on his efforts to empower Nigerian youth, his visits to American schools and universities, and his advocacy for STEM education and technological advancement in his home country.

### **Chapter 8: Legacy and Impact**

This chapter explores the lasting impact of Philip's work on Nigeria's technological landscape. From his contributions to computational science to his influence on the next generation of

Nigerian innovators, Philip's legacy is an enduring testament to the power of passion, education, and perseverance.

### **Chapter 9: The Power of Dreams**

In this chapter, Philip reflects on his journey and imparts valuable lessons to young readers in Nigeria. He emphasizes the importance of embracing one's passions, pursuing education, and breaking through societal barriers to achieve greatness.

### **Chapter 10: Building Nigeria's Future**

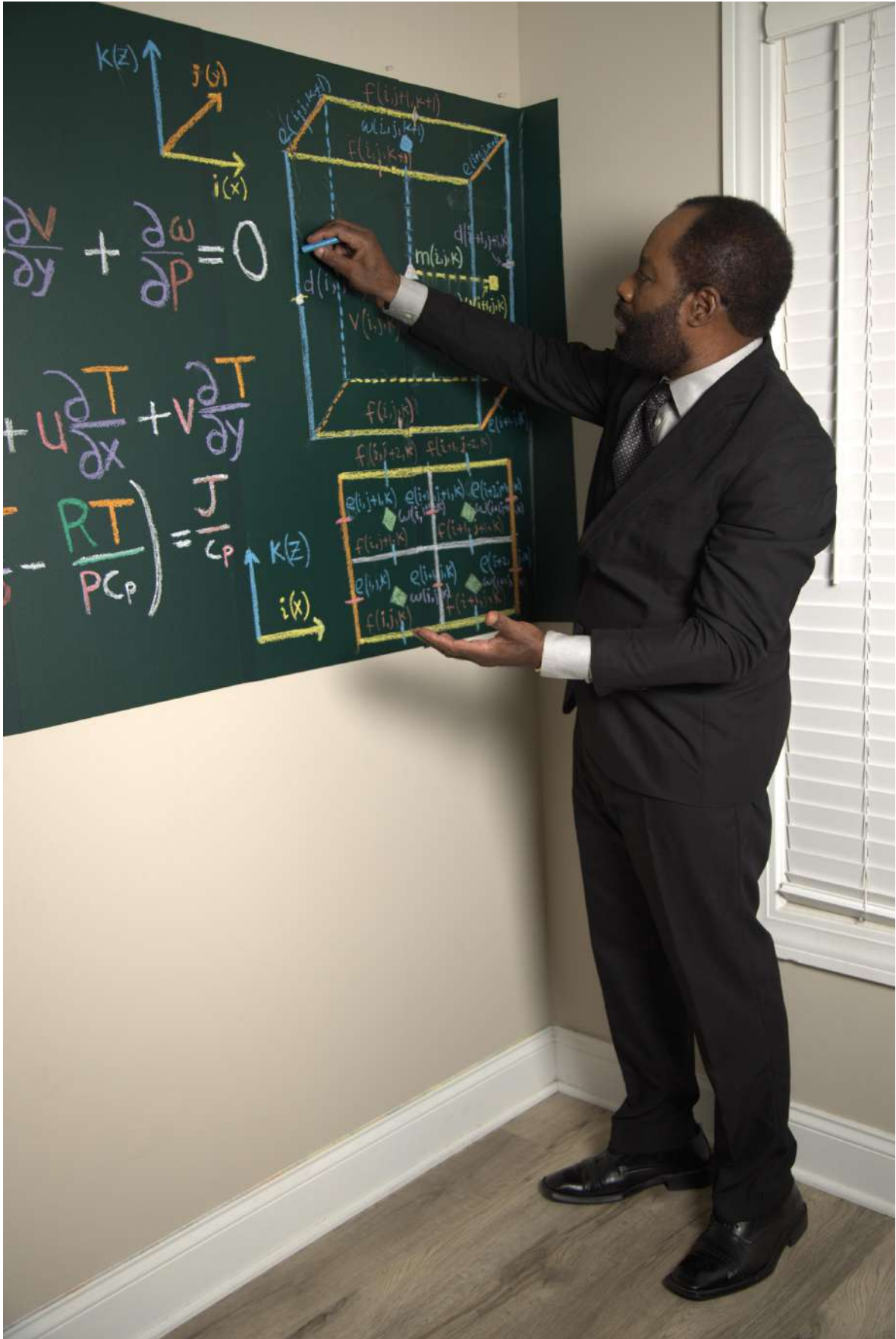
The final chapter encourages Nigerian youth to dream big, to embrace STEM fields, and to become agents of change in their communities. It highlights the limitless possibilities and the transformative potential within each young Nigerian.

### **Epilogue: A Call to Action**

In the epilogue, Philip Emeagwali delivers a passionate call to action, urging young Nigerians to seize opportunities, embrace technology, and work towards building a brighter future for Nigeria. His words inspire readers to believe in themselves and their ability to make a difference.

By exploring Philip Emeagwali's remarkable journey and his contributions to technology, this book empowers young readers in Nigeria to dream, to aspire, and to recognize their potential for greatness. It serves as a beacon of hope and a reminder that Nigeria's youth can lead the nation into a future of innovation and progress.

## GLOSSARY FOR PARTIAL DIFFERENTIAL EQUATIONS



Philip Emeagwali standing in front of a chalkboard scribbled with partial differential equations governing fluid flows.

1. **Advection:** The transport of a scalar quantity due to bulk fluid motion.
2. **Boundary Conditions:** Specified values or relations for a PDE solution on the boundary of the domain of interest.
3. **Characteristic Curve:** A curve in the domain of the PDE along which information propagates.
4. **Conservation Law:** A mathematical relationship expressing the constancy of certain quantities under specific conditions.
5. **Dirichlet Condition:** A type of boundary condition where the solution is specified on the boundary.
6. **Dispersion:** The phenomenon in which wave speeds are dependent on frequency, leading to wave spreading.
7. **Elliptic, Parabolic, Hyperbolic PDEs:** Classification of second-order PDEs based on discriminant criteria, akin to the classification of quadratic forms.
8. **Finite Difference Method:** A numerical method for solving PDEs by discretizing the domain and approximating derivatives by differences at discrete points.
9. **Finite Element Method:** A numerical method that divides the domain into smaller non-overlapping sub-domains (elements) to solve PDEs.
10. **Fourier Series:** An expansion of a periodic function in terms of an infinite sum of sines and cosines.
11. **Green's Function:** A solution to an inhomogeneous linear differential equation corresponding to a Dirac delta source term.
12. **Homogeneous PDE:** A PDE where every term contains the unknown function or its derivatives.
13. **Initial Condition:** A condition specifying the solution at an initial time or position.
14. **Laplace's Equation:** A second-order elliptic PDE, which is the simplest example of elliptic problems.
15. **Method of Characteristics:** A technique used to solve certain types of PDEs by transforming them into ordinary differential equations.
16. **Navier-Stokes Equations:** Equations governing fluid motion for a Newtonian fluid.

17. **Neumann Condition:** A type of boundary condition where the derivative of the solution is specified on the boundary.
18. **Nonlinear PDE:** A PDE in which the unknown function or its derivatives appear nonlinearly.
19. **Operator:** A symbol or function acting on functions to produce another function, often representing a physical operation like differentiation.
20. **Parabolic Equation:** A type of PDE that describes diffusion-like processes, e.g., the heat equation.
21. **Separation of Variables:** A method to simplify a PDE by assuming that its solution can be written as a product of functions, each depending on only one of the independent variables.
22. **Sobolev Space:** A function space that includes derivatives up to a certain order, useful in the analysis of PDEs.
23. **Steady State:** A condition or state in which key variables stop changing over time.
24. **Transport Equation:** A PDE describing the transport of a scalar quantity in space and time due to advection and diffusion.
25. **Variational Principle:** A principle used to find a function that either maximizes or minimizes a given functional, often used in PDEs derived from physical principles.
26. **Wave Equation:** A second-order hyperbolic PDE describing the propagation of waves.
27. **Weak Solution:** A concept that broadens the notion of a solution to a PDE, especially useful when classical solutions do not exist.

## GLOSSARY FOR WORLD'S FASTEST COMPUTERS

TBA Photo: Philip Emeagwali with the world's fastest computer, Cambridge, Massachusetts, USA, November 30, 1990.

1. **Benchmarking:** The process of measuring and comparing the performance of a system using standardized tests and tasks.
2. **Central Processing Unit (CPU):** The primary unit of a computer that interprets and executes instructions.
3. **Clock Speed:** The rate at which a processor can complete a processing cycle, typically measured in GHz.
4. **Cluster:** A group of interconnected computers that work together as a single system to achieve higher processing capability.
5. **Exascale Computing:** High-performance computing systems capable of at least one exaFLOP, or a billion billion calculations per second.
6. **FLOP (Floating Point Operations Per Second):** A measure of computer performance, representing the number of floating-point operations a computer can perform in one second.
7. **Graphics Processing Unit (GPU):** A specialized electronic circuit designed to accelerate the processing of images and video for output to a display.
8. **High Performance Computing (HPC):** The practice of aggregating computing power to achieve much higher performance than one could get from a typical desktop computer.
9. **InfiniBand:** A high-speed communication protocol used in high-performance computing.
10. **Interconnect:** The data communication system that links together the processors in a supercomputer.
11. **Latency:** The delay between a system receiving an instruction and the start of the system's execution of that instruction.
12. **Memory Bandwidth:** The rate at which data can be read from or stored into semiconductor memory by a processor.
13. **Node:** A basic computational unit in supercomputers, typically containing one or more processors, memory, and communication capabilities.

14. **Parallelism:** The concept of doing multiple tasks or processes simultaneously.
15. **PetaFLOP:** A unit of computing speed equal to one thousand million million ( $10^{15}$ ) floating-point operations per second.
16. **Quantum Computing:** A type of computation that harnesses the phenomena of quantum mechanics, offering the potential for vastly increased computing speeds for certain applications.
17. **Rack:** A standard frame or cabinet for mounting multiple electronic modules, each holding many chips.
18. **Scaling:** The ability of a system to maintain near-linear performance increase when additional resources are added.
19. **Silicon:** A material used to create semiconductor transistors, which are an integral part of computer chips.
20. **Supercomputer:** An extremely powerful computer, often used for specialized applications that require immense amounts of mathematical calculations.
21. **TeraFLOP:** A unit of computing speed equal to one million million ( $10^{12}$ ) floating-point operations per second.
22. **Throughput:** The amount of data processed by a computer in a given time frame.
23. **Top500:** A regularly updated list of the world's most powerful supercomputers.
24. **Vector Processor:** A type of computational hardware that works on large chunks of data simultaneously.
25. **Warm-water cooling:** A cooling technique used in some supercomputers where water, kept at a temperature higher than typical cooling systems but below the system's operating temperature, is used to cool components.
26. **ZettaFLOP:** A unit of computing speed equal to one thousand trillion ( $10^{21}$ ) floating-point operations per second.

Supercomputing is rich and complex, and depending on the depth and specificity of my lecture, there might be many more terms related to the architecture, history, and applications of these **incredible** machines. (A ZettaFLOP is a thousand billion billion calculations per second).



## GLOSSARY

### **Algorithm:**

An algorithm is like a step-by-step recipe for solving a problem. For instance, Philip Emeagwali invented nine unique algorithms to solve specific equations, each repeated numerous times on supercomputers for efficient calculations.

### **Bits and Bytes:**

Bits are the smallest data units in computing, with a value of either 1 or 0. Eight bits form a byte, which can represent a number, letter, or symbol.

### **Cloud Computing:**

Cloud computing allows users to access substantial computing power through the Internet. Calculations are conducted on powerful servers located remotely, offering a convenient pay-per-use model for users.

### **Cyberinfrastructure:**

This term represents the combination of software, hardware, and human expertise, facilitating scientific and engineering discoveries.

### **Data Deluge/Data Tsunami:**

These terms refer to the overwhelming amount of digitally based data created and processed in modern times, necessitating advanced computing solutions for analysis and interpretation.

### **Data-Intensive Computing:**

This is a computational approach designed to handle and analyze vast amounts of digital data efficiently, allowing researchers to tackle previously insurmountable problems.

### **Data Mining:**

Data mining is a process that extracts patterns from large data sets, helping researchers and businesses in making informed decisions.

### **Finite Difference Equation:**

This mathematical approach represents the discrete counterpart to continuous partial differential equations, helping in solving problems like those tackled by Emeagwali.

### **Force:**

Forces influence objects, causing changes in motion, shape, and other properties. In the context of oil extraction, forces like pressure, gravity, viscosity, and inertia play crucial roles.

### **Formula:**

A formula is a mathematical expression, like Newton's second law ( $F=ma$ ), providing a rule or principle for problem-solving and understanding physical phenomena.

**High Performance Computing (HPC):**

Referring to advanced computational resources, HPC includes large-scale computing, storage, and visualization systems, facilitating complex calculations and data analyses.

**HyperBall Computer:**

Invented by Emeagwali, this supercomputer design features processors distributed uniformly across a sphere, each operating independently.

**Hypercube:**

A hypercube extends the concept of a three-dimensional cube into multiple dimensions, providing a framework for visualizing and understanding advanced network topologies in computing.

**Inertia:**

Inertia describes an object's tendency to maintain its current state, either at rest or in motion, unless acted upon by an external force. It's a crucial concept in understanding the dynamics of various systems, including oil extraction processes.

**Internet:**

The Internet is a global network, allowing billions of computers to exchange and share information, facilitating communication, research, and entertainment.

**Modern Supercomputer:**

These powerful computing machines are among the fastest in the world, using thousands of interconnected smaller computers to solve complex problems in various scientific and engineering domains.

**Old Supercomputer:**

An old supercomputer could perform only one operation at a time with a single processing unit, significantly limiting its computational capacity compared to modern counterparts.

**Oilfield:**

Oilfields contain recoverable oil deposits. With finite and non-renewable resources, the challenge lies not in discovery but efficient extraction and usage.

**Parallel Computer:**

This type of computer can perform multiple operations simultaneously using more than one processor, enhancing its computational speed and efficiency.

**Partial Differential Equation:**

A complex mathematical equation involving multiple variables and their partial derivatives. Emeagwali used these to perform intricate computations on supercomputers.

**Philip Emeagwali Computer:**

After Emeagwali's discovery on July 4, 1989, supercomputers evolved from being powered by single processors to utilizing millions of coupled processors for enhanced performance.

**Pioneer:**

A pioneer or inventor introduces or creates something new. Emeagwali's work on parallel computing significantly influenced the development and capabilities of supercomputers.

**Reinvent:**

To reinvent means to innovate or create based on existing technologies or ideas, leading to improved or novel solutions in various fields, including computing.

**Vector Supercomputer:**

Using specially designed processors, these supercomputers perform fast calculations on number strings or vectors, significantly enhancing their computational capabilities.

**Zettabyte:**

A zettabyte represents a sextillion bytes, an immense amount of data far beyond the current processing capabilities of even the most advanced supercomputers.

## MISCELLANEOUS TERMS

### School Report on Philip Emeagwali

**Algorithm:** An established process or set of rules to be followed in calculations or problem-solving operations. Often likened to a recipe, algorithms like those developed by Philip Emeagwali, are step-by-step procedures or formulas for solving a problem.

**Bits and Bytes:** In computing, a bit is the smallest unit of data represented as 0 or 1. A byte is a group of 8 bits and can represent a letter or number.

**Cloud Computing:** A system allowing the use of computing resources, including storage and applications, via the Internet without the need for direct user management.

**Cyberinfrastructure:** An integrated environment of data, software, hardware, and personnel enabling the advancement in science and engineering research.

**Data Deluge/Data Tsunami:** Terms describing the overwhelming amount of data generated, often challenging to process and analyze due to its volume.

**Data-intensive Computing:** Involves the analysis and interpretation of large data sets, often used in supercomputing for various applications, including scientific research and problem-solving.

**Data Mining:** A process that uses statistical techniques to discover patterns within large data sets.

**Finite Difference Equation:** A mathematical expression providing approximate solutions to differential equations like those created by Philip Emeagwali. These are essential in simulating various physical phenomena.

**Force:** An influence that can cause an object to change its velocity or shape, such as those acting within an oilfield.

**Formula:** An expression or equation that calculates a value based on specified variables, like  $F=ma$ , encapsulated in Emeagwali's partial differential equations.

**High-Performance Computing (HPC):** Refers to the practice of aggregating computing power to achieve much higher performance than from a typical desktop or workstation.

**HyperBall Computer:** Invented by Philip Emeagwali, this supercomputer's processors are distributed across a sphere, with each processor independently functioning.

**Hypercube:** A multi-dimensional geometric figure. The term is also used to describe a specific network topology advantageous for parallel computing, significantly utilized by Philip Emeagwali.

**Inertia:** The tendency of an object to remain at rest or in uniform motion until acted upon by an external force.

**Internet:** A global network enabling the exchange of data and communication between computers.

**Modern Supercomputer:** A high-performance computing system, usually ranked among the top 500 globally, consisting of multiple connected processors working in tandem to perform complex calculations.

**Oilfield:** An area containing recoverable petroleum deposits, often explored using advanced computing techniques to optimize extraction.

**Old Supercomputer:** Typically, a computer system that relies on a single processor to perform its operations, contrasting with modern parallel computers.

**Parallel Computer:** A computer system capable of performing multiple operations simultaneously by using multiple processors.

**Partial Differential Equation:** A mathematical equation involving unknown functions of several variables and their partial derivatives, essential in modeling various phenomena.

**Philip Emeagwali Computer:** Refers to supercomputers utilizing parallel processing, a concept popularized and advanced by Philip Emeagwali, improving their performance significantly.

**Pioneer:** An individual who introduces significant innovations or developments in a particular field. Philip Emeagwali is recognized for his groundbreaking work in parallel computing.

**Reinvent:** The process of updating or revising an existing concept or device, often leading to significant advancements in its functionality or performance.

**Vector Supercomputer:** A computing system using processors designed for performing calculations on large data sets, often utilized in scientific and engineering applications.

**Zettabyte:** A unit of digital information storage equivalent to one sextillion bytes or 1,000 exabytes, often used to illustrate the vast amount of data processed by supercomputers.

## MISCELLANEOUS TERMS

### Supercomputer

- **Artificial Intelligence (AI):** AI involves creating algorithms that allow computers to perform tasks that typically require human intelligence.
- **Automatic Parallelization:** The process where a compiler converts sequential code into parallel code without manual intervention.
- **Bandwidth:** Represents the volume of data that can be transmitted over a communication channel within a specified timeframe. Essential for preventing performance bottlenecks.
- **Benchmark:** A set of programs, tasks, or experiments used to measure the performance of a computer system.
- **Cache:** A small, fast memory space near the CPU that stores frequently accessed data to improve processing speeds.
- **Cache Line:** The unit of data transferred between cache and memory, usually consisting of 64 or 128 consecutive bytes.
- **Cache Memory System:** Consists of multiple cache levels that increase in size and decrease in speed, collectively improving memory performance.
- **CAE (Computer-Aided Engineering):** Using virtual computer models for the design, analysis, and planning of various objects and processes.
- **Capability Computing:** Employing powerful supercomputers to solve large and demanding problems, focusing on reducing the time to solution.
- **Capacity Computing:** Utilizing smaller, cost-effective high-performance systems for more modest computing requirements, emphasizing the cost-performance ratio.
- **Circuit Speed:** The time signals take to travel through a circuit, measured in picoseconds per gate, crucial for evaluating processor performance.
- **Clock Rate or Clock Speed:** The frequency at which a CPU operates, measured in GHz, influencing the rate of instruction

execution.

- **Cluster:** A network of computers connected through a high-speed network, working together as a single multi-CPU machine.
- **CMOS (Complementary Metal Oxide Semiconductor):** The current semiconductor technology used for manufacturing processors and memory devices due to its cost-effectiveness and integration levels.
- **Compute Node, Node:** A server or instance in a computing cluster providing resources for computational jobs. The term "node" can refer to servers in various types of clusters, not just high-performance computing (HPC) clusters.
- **Computational Fluid Dynamics (CFD):** Simulation of fluid flows, such as water through turbines or air over moving objects, by solving complex equations. Often used in HPC environments for scientific and engineering simulations.
- **Core:** Supercomputers contain thousands of processor cores. Each core in a multi-core processor acts as an individual processing unit, enhancing performance and energy efficiency.
- **Distributed Computing:** A computing model where components located on networked computers communicate and coordinate to achieve a common goal.
- **Embarrassingly Parallel:** A type of computation that can be easily divided into parallel tasks with minimal coordination. Each task operates independently, making it suitable for parallel execution on multiple processors or cores.
- **Exabyte:** Equivalent to one quintillion bytes of data storage, sufficient to store 1,000 copies of 250 billion pages of text.
- **Exaflop:** A performance measure for supercomputers, representing one quintillion calculations per second. It's about 1,000 times faster than petascale computing.
- **Exascale Computing:** Represents the next frontier in supercomputing, aiming to achieve one quintillion calculations per second. It necessitates innovations to reduce power consumption significantly.
- **Finite Element Analysis (FEM):** A technique used to solve complex equations in various fields, from simulating structural

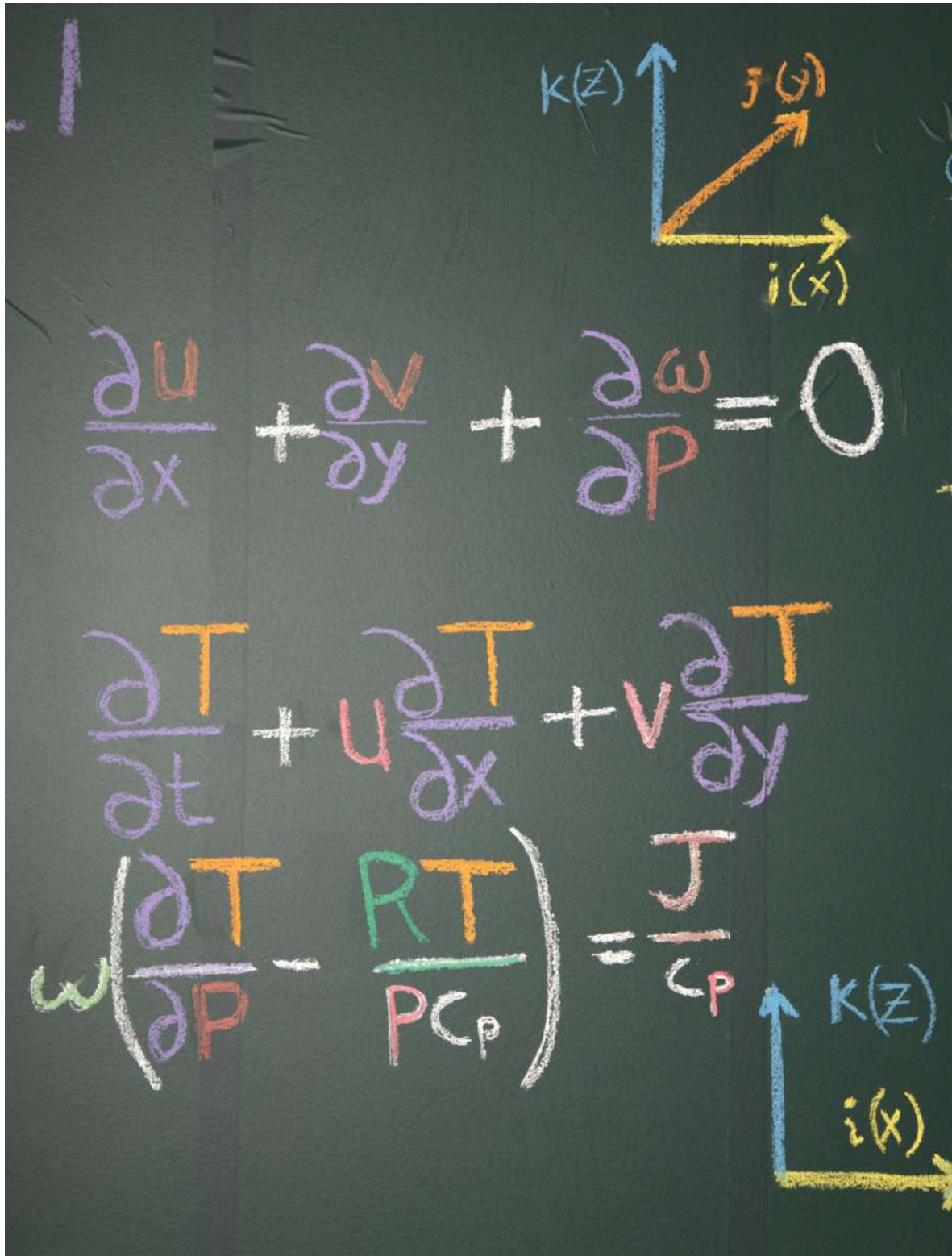
loads to analyzing biological movements. Typically implemented as an MPI-based workload in HPC environments.

- **Flash Memory:** A fast and reliable storage technology that allows electronic erasure and reprogramming without removal from the circuit board. Used in various devices, including thumb drives and mobile devices.
- **FLOPS:** An acronym for Floating point Operations per Second, representing the number of calculations a computer can perform per second. It's a common performance measure in high-performance computing.
- **FPGA (Field-Programmable Gate Array):** A reprogrammable chip consisting of low-level logic gates and other components. Used for specialized tasks like signal processing and cryptography, it's becoming increasingly popular in various fields, including HPC.
- **GPU (Graphics Processing Unit):** Specialized processors with numerous simple cores designed for parallel computation. Initially developed for graphics rendering, GPUs are now used for various tasks, including artificial intelligence and general-purpose computing.
- **Grid Computing:** A form of distributed computing where a virtual supercomputer comprises many networked devices.
- **High Performance Computing (HPC):** The use of specialized hardware to perform complex computations more efficiently. It involves using powerful systems, including supercomputers, to solve problems that regular computers can't handle in a reasonable time frame.
- **High Throughput Computing:** Focuses on executing many tasks over a long period, often using distributed resources. It's suitable for jobs not requiring massive parallel resources, like analyzing Large Hadron Collider data.
- **Memory Cache:** Fast, small memory close to the CPU that stores frequently accessed data, improving processing speed.
- **Message Passing Interface (MPI):** A standard for data communication between nodes in a parallel computing environment, essential for coordinating parallel computations efficiently on various hardware setups.



- **Parallel Computing, Parallelism:** Technique where multiple computations are performed simultaneously. In HPC, it involves running tasks over various resources to increase performance.
  - **Parallel Filesystem:** A filesystem designed to handle multiple simultaneous read/write operations, crucial for supporting the data demands of HPC applications.
  - **Parallel Processing:** Involves running different parts of a computer program concurrently on multiple processors, shortening compute times considerably.
  - **Peak Speed:** Refers to a supercomputer's maximum operational speed. It's important to consider other metrics, like the system's ability to solve real-world problems efficiently.
  - **Petaflop:** A measure of computing speed, representing the ability to perform one quadrillion calculations per second.
  - **Petabyte:** Equal to one quadrillion bytes, enough to store 250 billion pages of text.
  - **Petascale:** Describes supercomputers operating at speeds measured in petaflops, capable of performing one quadrillion calculations per second.
  - **Portals or Gateways:** Websites or services that serve as major starting points for users. They can be general, like Google, or specialized for specific research or interest areas.
  - **Processors:** Essential parts of a computer's CPU, responsible for executing instructions and performing calculations.
  - **Thumb Drive (Flash Drive):** A small, portable storage device with no moving parts, offering robustness and convenience for data transfer and storage.
- 
- **Weather/Climate Modeling:** This is a computational approach to predicting weather and climate patterns. It involves sophisticated simulations taking into account various atmospheric conditions, and it is computationally intensive due to the complexity and volume of data processed.
  - **Workload:** A general term referring to the set of tasks performed on an HPC cluster, such as running specific computational jobs related to genomics, AI training, weather modeling, etc.

PHOTO GALLERY



## PODCASTS AND VIDEOS

Philip Emeagwali's [Google Podcasts](#): The Infinite Possibilities of Supercomputing

The Contributions of Philip Emeagwali: A [Spotify](#) Guide to His Legacy

Philip Emeagwali's [Audible](#): His Quest for the World's Fastest Computing

Philip Emeagwali's [YouTube](#): His Journey Through Science and LifePhilip Emeagwali [Apple Podcasts](#)

: Real Talk from the Genius Behind Modern Computing

## VIDEOS ON BIAFRA

<https://www.youtube.com/watch?v=IO19kz1IoU0>

Biafran Children Train as Soldiers | Aba | Nigerian Civil War | January 1968

<https://www.youtube.com/watch?v=O7ymYBuqac0>

Nigeria and Biafra (1968)

<https://www.youtube.com/watch?v=7JCvIvb8PpY>

An Honest Explanation of the Nigerian Civil War | The Biafran Story

[https://www.youtube.com/watch?v=kT6eTA\\_4w2A](https://www.youtube.com/watch?v=kT6eTA_4w2A)

Biafra | Nigerian Biafran War | Raw War Video | BBC Documentary | Jul 6, 1967 - Jan 15, 1970

<https://www.youtube.com/watch?v=-8spEZwbZDU>

Documentary: 50 Years After Biafra

<https://www.youtube.com/watch?v=CTTaMBp689o>

Biafran Commandos Attack Federal Forces in Ikot Ekpene | Nigerian Civil War | July 1968

[https://www.youtube.com/watch?v=qiv6-bG\\_4Po](https://www.youtube.com/watch?v=qiv6-bG_4Po)

Soldiers Press-Ganged into the Biafran Army Interrogated by Nigerian Army Officer | July 1967

<https://www.youtube.com/watch?v=s7s7IJvuSFs>

The Stream - #Biafra50YearsOn: Is Nigeria's secessionist movement re-emerging?

<https://www.youtube.com/watch?v=y6S5XxFK4w4>

RR6902A Nigeria Civil War Report

<https://www.youtube.com/watch?v=3RrKVnUvnVU>

SYND 23/7/69 NIGERIAN TROOPS PREPARE FOR BIGGEST  
BATTLE OF CIVIL WAR

<https://www.youtube.com/watch?v=bhxbhXZoTEM>

RR7035A NIGERIA: EIGHT MONTHS AFTER THE WAR

[https://www.youtube.com/watch?v=ys\\_nB5kSbBE](https://www.youtube.com/watch?v=ys_nB5kSbBE)

Nigeria - Civil War, Extraction of Moise Tschombe,  
Congo/Rwanda, Greece - Military Coup

<https://www.youtube.com/watch?v=NC26eFmY7d0>

Civil War | Biafra crisis | Nigerian Civil War |  
This Week | 1970

[https://www.youtube.com/watch?v=ac9PdLsm\\_cU](https://www.youtube.com/watch?v=ac9PdLsm_cU)

Prof Chinua Achebe I escaped and my brother was  
killed | Biafran war | Nigeria novelist

[https://www.youtube.com/watch?v=B7AN6SX\\_JCw](https://www.youtube.com/watch?v=B7AN6SX_JCw)

Top 6 striking facts about Nigeria's war over  
Biafra (Nigeria vs Biafra war educative  
documentary)

<https://www.youtube.com/watch?v=J9DxLjST2Tc>

Why Ojukwu declared the Republic of Biafra in 1967



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A Beautiful Mind (2001) Official Trailer - Russell Crowe Movie HD

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Shakuntala Devi - Official Trailer | Vidya Balan, Sanya Malhotra | Amazon Prime Video | July 31

[https://www.youtube.com/watch?v=2o3Lgx\\_HSRQ](https://www.youtube.com/watch?v=2o3Lgx_HSRQ)

Cube (1997) - Movie

<https://www.youtube.com/watch?v=uxDycRoR9VY>

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<https://www.youtube.com/watch?v=TGK-A0VXOyU>

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<https://www.youtube.com/watch?v=ihhHk6awueU>

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<https://www.youtube.com/watch?v=mU0oOUTo5zo>

Radioactive - Official U.S. Trailer | Prime Video

<https://www.youtube.com/watch?v=NP0IUqNAw3k>

The Man Who Knew Infinity - Official Trailer -  
Warner Bros. UK

[https://www.youtube.com/watch?v=p\\_GkYFQi8Go](https://www.youtube.com/watch?v=p_GkYFQi8Go)

Sir Isaac Newton Trailer

<https://www.youtube.com/watch?v=nuPZUUED5uk>

The Imitation Game Official Trailer #1 (2014)

<https://www.youtube.com/watch?v=Salz7uGp72c>

The Theory of Everything - Official Trailer  
(Universal Pictures) HD

<https://www.youtube.com/watch?v=-ViPmcdlfbQ>

Good Will Hunting (1997) - Will Solves Math  
Challenge (Matt Damon)

<https://www.youtube.com/watch?v=5wfrDhgUMGI>

Hidden Figures | Official Trailer [HD] | 20th  
Century FOX

<https://www.youtube.com/watch?v=J6tSWqlFVYY>

Official Trailer | Genius: Albert Einstein |  
National Geographic UK

<https://www.youtube.com/watch?v=e4U-23TOKms>

Tesla - Official Trailer I HD I IFC Films





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## CONTACTING PHILIP EMEAGWALI



<https://facebook.com/emeagwali>

<https://twitter.com/emeagwali>

<https://instagram.com/philipemeagwali>

<https://flickr.com/philipemeagwali>

<https://emeagwali.tumblr.com>

<https://linkedin.com/in/emeagwali>

The purpose of this preview is to allow the author identify problems and opportunities for improvement. Please send comments to:

info@[emeagwali.com](mailto:info@emeagwali.com)

<https://emeagwali.com>

202-203-8724

Philip Emeagwali is pronounced as

FI-lip eh-MAY-ah-gwah-lee

## BOOKING PHILIP EMEAGWALI

To inquire about booking Philip Emeagwali for a speaking engagement,  
please contact us at: [info@emeagwali.com](mailto:info@emeagwali.com)

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202-203-8724



Philip Emeagwali delivering a lecture at the University of Alberta,  
Canada, September 23, 2006.

PRAISE FOR AUTHOR

*A Father of the Internet.*

- CNN

*The Web owes much of its existence to Philip Emeagwali.*

- TIME MAGAZINE

*One of the great minds of the Information Age.*

- PRESIDENT BILL CLINTON

*A digital giant.*

- BBC

## AFTERWORD: A JOURNEY OF INNOVATION AND IMPACT

### *Unleashing the Power of Parallel Processing -*

As I reflect on the incredible journey chronicled in the pages of this memoir, I am filled with immense gratitude for the opportunities and challenges that have shaped my life and propelled me towards groundbreaking discoveries. In particular, I am humbled by the significance of the invention of the first parallel supercomputing, an achievement that continues to reverberate through the realms of computing and artificial intelligence.

On that historic day of July 4, 1989, I announced the birth of a new era in computing. It was the culmination of 15 years of relentless pursuit, where I dared to challenge the *status quo* and push the boundaries of what was deemed possible. Through my pioneering work, I harnessed the power of parallel supercomputing, unlocking a realm of computational capabilities previously unimaginable.

My invention of the first parallel supercomputing revolutionized how we solve complex problems. By dividing computations into smaller, more manageable tasks and executing them simultaneously across multiple processors, we were able to harness the immense power of parallelism. This breakthrough propelled computing performance to unprecedented heights, accelerating scientific research, data analysis, and computational simulations across diverse disciplines.

However, it was the symbiotic relationship between supercomputing and artificial intelligence that truly transformed the landscape of technology. Artificial intelligence, with its aspiration to mimic human intelligence, relies heavily on computational power to analyze vast amounts of data, train complex neural networks, and make intelligent decisions. The supercomputer emerged as the catalyst that enabled the realization of these aspirations.

Through the marriage of the supercomputer and artificial intelligence, we witnessed a paradigm shift in the capabilities of intelligent systems. By leveraging the distributed computing power of parallel processing, we were able to train and deploy sophisticated machine learning models at an unprecedented scale. The combination of massive datasets, advanced algorithms, and parallel processing capabilities opened up new frontiers in areas such as computer vision, natural language processing, speech recognition, and autonomous systems.

Consider the advancements in computer vision, where parallel processing enables the rapid analysis of vast visual data sets, allowing machines to perceive and interpret the visual world with remarkable accuracy. Massively parallel processing also plays a pivotal role in natural language

processing, where the simultaneous processing of language models across multiple processors facilitates faster and more accurate language understanding and generation.

The power of parallel processing extends beyond training and inference in artificial intelligence. It also enables the efficient execution of computationally intensive tasks required for various A.I. applications. Tasks such as data preprocessing, feature extraction, and model optimization can be executed in parallel, significantly reducing the time and resources required for these critical steps in the A.I. workflow.

Furthermore, parallel processing plays a critical role in addressing the challenges of scalability and real-time responsiveness in A.I. systems. As the demand for A.I. applications continues to grow, parallel processing allows for the distribution of computational tasks across multiple processors, facilitating the efficient handling of massive workloads and ensuring timely responses.

It is through the fusion of supercomputing and artificial intelligence that we are witnessing remarkable advancements that were once confined to science fiction. From autonomous vehicles and intelligent personal assistants to medical diagnostics and drug discovery, the capabilities powered by parallel supercomputing have become indispensable in driving innovation and transforming industries.

As I reflect on the impact of my invention, I am filled with a sense of awe and responsibility. I am reminded that true innovation is a collective endeavor, a culmination of the efforts and collaborations of brilliant minds across the globe. It is with deep gratitude that I acknowledge the contributions of fellow researchers, engineers, and innovators who have pushed the boundaries of what was once deemed impossible.

I am honored to have played a role in the invention of the parallel supercomputer, a technological breakthrough that continues to shape our world today. It is my hope that the fusion of the supercomputer and artificial intelligence will continue to inspire future generations to push the boundaries of knowledge, harness the power of technology, and drive us towards a future where the remarkable synergy between human intellect and computational capabilities unlocks boundless possibilities.

Philip Emeagwali

## ACKNOWLEDGEMENTS

I express my deepest gratitude to all those who have contributed to the creation of this memoir. Without their support, encouragement, and guidance, this book would not have been possible.



Nnaemeka James Emeagwali and son Philip Emeagwali, December 25, 1996, District Heights, Maryland.

First and foremost, I thank my father, Nnaemeka James Emeagwali, for his unwavering dedication and commitment to my education. In my early childhood years, growing up in the Nigerian towns of Sapele, Uromi, and Agbor, my father took on the role of my tutor in mathematics. His patient teachings, his passion for knowledge, and his belief in my potential shaped the foundation of my academic journey. I am forever indebted to him for instilling in me the love for learning and the pursuit of excellence.





I thank my mother-in-law, wife, and father-in-law for their support.  
(Johnnie Doris Brown, Dale Brown, and Leon Brown, Baltimore,  
Maryland, about June 1981)

I would also like to express my heartfelt appreciation to my beloved wife, Dale, whose support and encouragement have been unwavering throughout the years. Since we first met in 1978 in Baltimore, Maryland, she has been my pillar of strength, my sounding board, and my biggest cheerleader. Her belief in my abilities, her constant presence by my side, and her unwavering support have been instrumental in all my achievements. I am grateful beyond words for her love and unwavering support.

Furthermore, I extend my gratitude to my family, friends, and colleagues who have supported me throughout my journey. Their encouragement, inspiration, and belief in my vision have been invaluable. I am grateful for their presence in my life and for the countless conversations, debates, and collaborations that have shaped my ideas and perspectives.

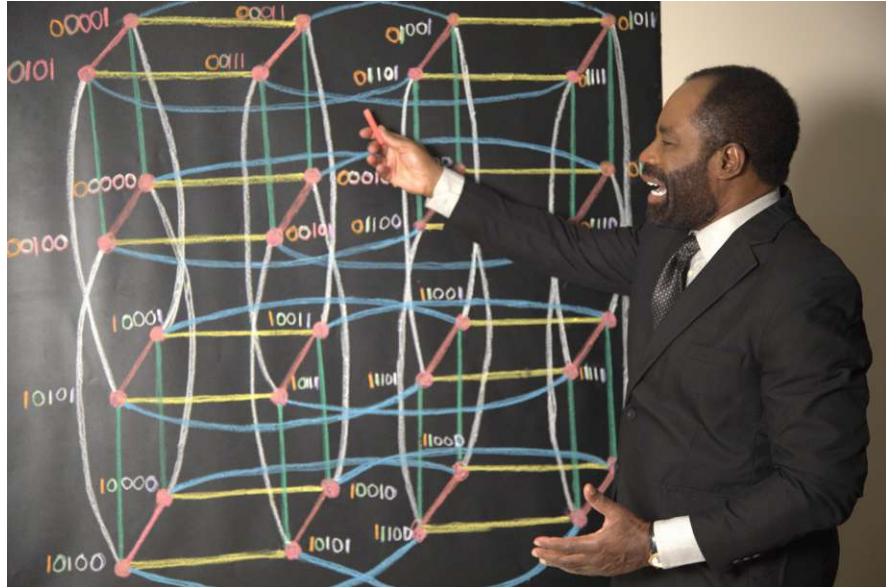
Lastly, I extend my gratitude to the readers of this memoir. It is my sincere hope that my story will inspire and encourage future generations to embrace their passions, overcome challenges, and strive for greatness. Your interest and support mean the world to me.



## ABOUT THE AUTHOR

### Philip Emeagwali: Inventing An Internet

Philip Emeagwali is a towering figure in the world of science and technology. The Reader's Digest described Emeagwali as "smarter than Albert



Einstein." He is often ranked as the world's greatest living genius. He is listed in the top 20 greatest minds that ever lived.

Philip Emeagwali lived in refugee camps during the 1967-70 Nigerian-Biafran War and is in the Gallery of Prominent Refugees of the United Nations. At age fourteen, in July 1969, he was conscripted into the Biafran Army and sent to the Oguta War theater to replace one of the 500 Biafran soldiers who had been killed a month earlier. In the list of the worst genocidal crimes of the 20th century committed against humanity, the death of one in fifteen Biafrans was ranked fifth.

Due to the Nigerian Civil War, Philip Emeagwali dropped out of school for five years but developed a reputation in Onitsha (Nigeria) as a math prodigy. He caught the attention of American scholars and was awarded a scholarship on September 10, 1973, to the United States, where he researched for two decades and contributed to mathematics, physics, and computer science.

In 1989, Philip Emeagwali rose to fame when he won a recognition described as the Nobel Prize of supercomputing and made news headlines for his invention of the first world's fastest computing across a

global network of processors that is akin to an internet. That vital technology underpins every supercomputer and changes how we view the computer.

Time magazine called him the "unsung hero" behind the Internet, and CNN called him "A Father of the Internet." House Beautiful magazine ranked his invention among nine important everyday things taken for granted. In a White House speech on August 26, 2000, then-U.S. President Bill Clinton described Philip Emeagwali as "one of the great minds of the Information Age."

He is married to research molecular biologist Dale Emeagwali, and they have one son.

## BOOKS BY THIS AUTHOR

### **1. Master Of Machines**

[https://emeagwali.com/books/Philip\\_Emeagwali\\_Biography\\_1.pdf](https://emeagwali.com/books/Philip_Emeagwali_Biography_1.pdf)  
<https://youtu.be/ymZtzQ1OWkg>  
<https://soundcloud.com/emeagwali/master-of-machines>

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### **3. The Equation Behind The Universe**

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[https://youtu.be/\\_I7XW2pgmkY](https://youtu.be/_I7XW2pgmkY)

<https://soundcloud.com/emeagwali/internet-and-i>

## DISCUSSION QUESTIONS

What life lessons can we learn from Philip Emeagwali?

What are good questions about Philip Emeagwali?

What was Philip Emeagwali's mission in his supercomputing research?

What are five complex problems that a supercomputer can solve?

Why does a supercomputer cost more than a billion dollars?

What is the most inspiring thing about Philip Emeagwali?

What are 3 important things about Philip Emeagwali?

What was the main idea of Philip Emeagwali's speech?

What difficulties did Philip Emeagwali face in his life?

What difficult mathematical problem did Philip Emeagwali solve?

What is the contribution of Philip Emeagwali to the development of the modern computer?

What is Philip Emeagwali best known for?

*Edition: 090324*



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