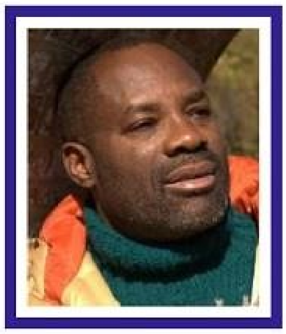
45 Father of the Internet—Part 3 of 15



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45.1 I Discovered a New Way of Computing

In 1989,
I **experimentally discovered**
massively parallel processing,

or how to communicate across computers,
and then compute **simultaneously**.
I **invented**
how to harness
64 binary thousand processors,
each processor akin to a tiny computer,
within a new internet.
I **invented**
how to parallel program many processors
and parallel program them
to compute together
as one seamless, cohesive supercomputer
that was the precursor
to the modern supercomputer.
I **invented**
how to solve the toughest problems
in calculus
and how to solve them across
64 binary thousand processors.
My **experimental discovery**
of the parallel processing power
of the **precursor**
to the modern supercomputer

opened the door
to today’s fastest supercomputer
that is powered by
ten million
six hundred and forty-nine thousand
six hundred [10,649,600]
processors.
A few days after my **1989**
experimental discovery
of massively parallel processing,
The Computer Society
of the IEEE
that was the world’s largest
computer society
issued a press release
announcing that I—**Philip Emeagwali**—
achieved a technological breakthrough
in supercomputing.
The IEEE is the acronym
for the Institute
of Electrical and Electronics Engineers.
In the May 1990 issue
of its academic journal

named "Software," 2128
the Computer Society of IEEE
published an article
on my experimental discovery
of how to harness the computing power
of massively parallel processing
supercomputers.
In that IEEE article,
four supercomputer experts
described how I invented
how to solve the toughest problem
arising in calculus.
The four supercomputer experts wrote that:

[quote]
"The amount of money at stake
is staggering.
For example,
you can typically expect to recover
10 percent of a field's oil.
If you can improve your production schedule
to get just 1 percent more oil,
you will increase your yield

by $400 million."
[unquote]

That 1989 press release
that announced my
technological breakthrough
in massively parallel processing
and the companion article
published by the IEEE
led to cover stories
in mathematics publications
and stories on my mathematical discoveries,
and, in particular, stories
on my contributions
of newly discovered algebra
to known algebra
and newly discovered calculus
to known calculus.
My contributions to algebra and calculus
were the front page story
of the June 1990 issue
of the *SIAM News*.
The *SIAM News*

is where new discoveries in mathematics
are described by mathematicians
and for mathematicians.

45.1.1 Solving the Toughest Problem in Calculus

My sixteen-year-long mathematical quest
to discover how to solve
the toughest problem arising in calculus
began on Thursday June 20, 1974.
That mathematical quest began on
one of the world's fastest supercomputers
that was at 1800 SW Campus Way,
Corvallis, Oregon, United States.
Sixteen years prior to my arrival
in the United States,
the first oil field in West Africa
was discovered in Nigeria.
The sister problem
to my mathematical quest

was to discover how to recover
the most crude oil and natural gas
and recover them
from a newly discovered crude oil and
natural gas field
in Nigeria.
For West Africa's first oil field
that was discovered in 1958
at **Oloibiri**, Eastern Region,
of the British West African colony of Nigeria,
only about one in ten
discovered barrels of oil
could be recovered by using only
primary technologies,
such as merely digging
a mile-deep hole
into the oil field.
Secondary technologies,
such as simulating the motions
of the crude oil, injected water, and natural
gas
flowing from water injection wells
to productions wells

are used to recover more crude oil and
natural gas.
For the four decades,
inclusive of the 1950s through ‘60s,
the supercomputer
was used to simulate the motions
of crude oil, injected water, and natural gas
and used to discover and recover
otherwise elusive
crude oil and natural gas.
For those four decades,
the supercomputers purchased
by the petroleum industry
were powered by **only one** isolated
processor.
That isolated processor
was not a member
of an ensemble of processors
that communicates and computes
together
and as one seamless, cohesive
supercomputer.

In 1989, it made the news headlines
that a lone wolf
African supercomputer wizard
in the United States
had invented
how to harness a new internet
that is comprised
of a new global network of
65,536
commodity-off-the-shelf processors
and discovered
how to use that new internet
to simulate the flow of crude oil, injected water, and natural gas.
I—**Philip Emeagwali**—
was that African supercomputer scientist
that was in the news in 1989
and in the news
for experimentally discovering
massively parallel processing.
That experimental discovery
changed the way
we look at the supercomputer.

In the old way, 2134
we looked at the supercomputer
as harnessing the power of only one **isolated**
processor.
In the new way,
we looked at the modern supercomputers
as computing **faster**
by harnessing the power of up to
ten million
six hundred and forty-nine thousand
six hundred [10,649,600]
processors.
After my experimental discovery
of massively parallel processing,
one in ten supercomputers
are purchased by the petroleum industry
alone.
Briefly, the supercomputer
improves global economic growth.
The fastest supercomputer
can cost more than the spacecraft
that took men to the moon.
I invented

how to use the modern supercomputer
to solve the toughest problems
arising in calculus.

45.1.2 Parallel Processing the Toughest Problems

I invented
how to parallel process
by processing many things (or processes)
at once
and processing them
to solve the toughest problems
arising in calculus
and solving them **across** a new internet
that is a new global network of
64 binary thousand
processors.
My invention
made the news headlines in 1989
and opened the door
to the modern supercomputer

that now computes 2136
with up to ten million
six hundred and forty-nine thousand
six hundred [10,649,600]
processors.
For the four decades
onward of 1946,
the year the programmable computer
was invented,
the computer itself was redefined
by the speed of its one
and only one **isolated**
processor
that was not a member
of an ensemble of processors.
That processor
solved only one mathematical problem
at a time.
In those four decades,
parallel processing,
or solving many problems **at once,**

and solving them across as many
processors
seemed so impossible
that no supercomputer scientist
would touch parallel processing
with a ten-foot pole.
Solving the toughest problem
in calculus
is defined as theoretically and
experimentally inventing
how to harness a new internet
that is a new global network of
65,536 tightly-coupled
already-available
processors
and harness that new internet
to compute 65,536 times **faster**
than one computer
that computes with only one **isolated**
processor.
The grand challenge in calculus

was to invent
how to harness
the total processing power
of that new internet
and harness it while solving
the toughest
and the most important problems
that will make the world a better place,
and a more knowledgeable one.

45.2 How I Solved the Toughest Problem in Calculus

45.2.1 They Called Me "Calculus"

Many school reports are biographies
of famous mathematicians
and their contributions to mathematics.
A seventh grader
from Rhode Island, United States
that was writing a school report

asked me:
"What did **Philip Emeagwali**
contribute to mathematics?"
If he was a research mathematician,
my answer—in the *lingua franca*
of mathematicians—
will be that I contributed
a system of coupled, non-linear,
time-dependent, and state-of-the-art,
hyperbolic
partial differential equations
that is the toughest problem in calculus
that are known as
Philip Emeagwali's equations.
Since he was only a seventh grader,
my simplified answer was that
I used my newly discovered calculus
to invent
how and why parallel processing
makes modern computers **faster**
and makes the new supercomputer
the **fastest,**
namely, **the Philip Emeagwali formula**

that then United States President Bill Clinton described in his White House speech of August 26, 2000.

My contributions to calculus
was cover stories
of top mathematics publications
of the year 1990.
However, I began my journey
to the cover stories
of mathematics publications
and began it twenty years earlier.
During a high school reunion
at Christ the King College,
Onitsha, Nigeria,
my school mates, from 1970,
only remembered me
by my nickname "Calculus,"
not by my real name "**Philip Emeagwali**."
They called me "Calculus"
because I was seen
with the 568-page blue hardbound book

that was titled:
"An Introduction
to the Infinitesimal Calculus."
That calculus book was subtitled
"With Applications to Mechanics
and Physics."
That calculus book was written by
G.W. [George William] Caunt.
That calculus book was published by
Oxford University Press.
Calculus
is the foundation
of extreme-scale computational physics.
Calculus
is the common denominator
between physics and the supercomputer.
I studied calculus
in June 1970, when I was in the eighth grade.
I studied calculus for twenty years
before my contributions to calculus
were recognized, as the cover story
of the June 1990 issue
of *SIAM News*.

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The *SIAM News*
is the flagship publication
of the Society of Industrial
and Applied Mathematics
that was the premier society
for research mathematicians.
If a research supercomputer scientist
that embarked on a quest
for the fastest supercomputer
is a polymath,
there is a reservoir of knowledge
that he or she can tap into
when tasked to solve
the grand challenge problem,
or the toughest problem,
in supercomputing.
It was called the toughest problem
because it seemed impossible
to solve.
That grand challenge problem traverses the
frontiers of knowledge
in physics, mathematics,
and computer science.

My 1970 textbook titled:
"An Introduction
to the Infinitesimal Calculus"
is in the public domain,
and can be read and printed online
with no cost.
That textbook contains
the foundational knowledge
to the partial differential equations
of calculus
that must be solved across
64 binary thousand
processors
that was used to define
the toughest problem in supercomputing.
A person trained only
in the computer sciences
cannot solve ten, or perhaps one,
problem randomly selected
from that public domain textbook.
Therefore, a person trained only
in the computer sciences
cannot solve the grand challenge

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of supercomputing
that implicitly requires the solution
of the toughest problem
in calculus.

I am asking you:
how can you solve
the toughest problem
in calculus
when you cannot solve
the easiest problem in calculus?
A supercomputer scientist
that was only at the **frontier** of computing
cannot solve the toughest problem
in supercomputing
that is defined and posed
at the crossroads
of the frontiers
of the partial differential equations
of calculus,
and that is defined and posed
at the crossroads
of the frontiers

of the most large-scale system of equations
of algebra,
and that is defined and posed
at the crossroads
of the frontiers
of the most large-scale
computational physics,
and that is defined and posed
at the crossroads
of the frontiers
of the most massively parallel
supercomputer
ever built.
I took twenty years,
onward of June 1970,
to arrive at those frontiers
and then to cross them
and into the uncharted territory
that was the massively parallel
supercomputer
that is the pre-cursor
of the modern supercomputer.
For me, it was a wild journey

through the minefields
of uncharted technological territories.
I say that the genius
is an average person
that worked hard
to become above average.

45.2.2 Contributions of Philip Emeagwali to Calculus

In 1989, I was in the news
for my contributions to mathematics.
I contributed
nine partial differential equations
to calculus.
And calculus is the powerful technique
that is the crown jewel of mathematics.
I contributed
new algebraic knowledge
of how to solve
the longest system of equations

of algebra
and how to solve them
across the largest ensemble
of processors.
I contributed new mathematical knowledge
of how to approximate
systems of partial differential equations
of calculus
and approximate each system
with an almost equivalent
system of equations
of algebra.
I contributed to computational mathematics
the new knowledge
of how to email portions
of those algebraic equations
and email them
to 65,536, or two-raised-to-power sixteen,
processors
and to email them to their unique
sixteen-bit long

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email addresses
that was a unique string of sixteen
zeroes and ones.

45.2.3 Thirty Thousand Years…In One Day

I invented
how to solve them **across**
each of those processors
and solve them
with sixteen orders of magnitude
increase in supercomputing speed.
I invented
how to compress 65,536 days,
or 180 years,
of **time-to-solution**
and compress that **time-to-solution**
to only one day
of **time-to-solution**,
and compress that **time-to-solution**
by sixteen orders of magnitude.

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My experimental discovery
of 180 years in one day
opened the door
to the state-of-the-art
in supercomputing
of reducing 30,000 computing-years
on an isolated processor
to only one supercomputing-day
across an ensemble of
10.65 million processors.
It is the massively parallel processing
that I invented
that powers the number one
supercomputer in the world.
That supercomputer
that is powered by **10.65 million**
processors
that compute in parallel.

45.2.4 Newsworthy Contributions to Calculus

Those contributions to calculus, algebra,
and supercomputing
were the reasons I—**Philip Emeagwali**—
was the cover stories
of top mathematics publications,
such as the cover story
of the June 1990 issue *SIAM News*
that was published by the Society
of Industrial and Applied Mathematics.
During the twenty years
onward of June 1970,
I spent the first decade
learning mathematics
and spent the second decade
contributing new equations to mathematics
that are named
Philip Emeagwali's equations.

45.2.5 The Calculus of Philip Emeagwali

And my contribution
to modern and abstract calculus
had become **newsworthy** and **noteworthy**
to the extent I was getting telephone
calls from the likes of
G.W. [George William] Caunt
to speak at top mathematics conference
which led to my lecture on July 8, 1991
in Washington, D.C.
at the International Congress of Industrial
and Applied Mathematics
that was the biggest gathering of
mathematicians.
G.W. Caunt wrote the *magnus opus* titled:
"**An Introduction
to the Infinitesimal Calculus.**"
It was subtitled:
"With Applications to Mechanics
and Physics."

If G.W. Caunt
could have revised his *magnus opus*
he will revise a 1989 edition
of his nineteen fourteen [1914] edition
of his five hundred and sixty-eight [568-]
paged *magnus opus*.
And G.W. [George William] Caunt
will update his 1914 calculus
with a forty-page contribution
on 1989 calculus
that was written by **Philip Emeagwali**
and subtitled:
"**With Supercomputer Applications**."
Or with applications to
parallel process**ing**
across millions of processors.
Calculus is a living body of knowledge
that has grown continuously
since it was invented
three hundred and thirty years ago.
My contributions to calculus

represent its growth
—from the 17th century's blackboard
to the mid-twentieth century's motherboard
and its expected growth across
up to one **binary billion** motherboards
of the twenty-first century.
My contributions to calculus
that was front-page news in 1989
represent its growth
across the 75 years onward of 1914.
To any mathematician
that came of age
at the beginning of the 20th century,
my contributions to **calculus**
turned mathematical science fiction
to non-fiction.

45.3 I Changed the Way We Solve the Toughest Problems in Calculus

45.3.1 Calculus and Computing

The reason **Philip Emeagwali**
is the subject of school reports
—on inventors and their inventions
and on mathematicians

and their contributions to mathematics—
is that I invented
how to execute large-scale
floating-point arithmetical computations
and a new method of computing in calculus.
I changed the way
we solve the toughest problems
in calculus
and changed it from solving it
on only one isolated processor
to solving it **across**
an ensemble of processors.
Such computation-intensive problems
had their roots

in a large-scale system of equations 2155
of algebra.
I translated those system of equations
from a system of
partial differential equations
of calculus
that I formulated
from a set of laws of physics.
I invented
how to compress
65,536 days, or 180 years,
of **time-to-solution**
on one processor
of the most extreme-scale problems
in computational physics.
I invented
how to compress **time-to-solution**
from 180 years on one computer
to only one day of **time-to-solution**
across one internet.
I invented that new internet

as a new global network of
65,536 processors,
each akin to a tiny computer,
that were identical and equidistant
from their nearest-neighboring units.
I invented that new internet
as a global network of
as many computers
that were identical
and were identically connected
and were equal distances **apart**.
That invention
was beyond mathematics textbook writing
and science fiction writing.
In today’s market,
the sixteen supercomputers
that I programmed as a lone wolf
and programmed in the 1980s
cost the budget of a small nation.
In the 1970s and ‘80s,
I conducted my research alone

and conducted my research 2157
in the uncharted territory
of the massively parallel supercomputer
that is the pre-cursor
of the modern supercomputer.
I conducted research alone
and I did so because it was
the toughest problem in supercomputing.
I conducted research alone because
the 25,000 programmers
of the vector processing supercomputers
of the 1980s
were terrified
thinking about **synchronously** sending
and **simultaneously** receiving
65,536
email messages
that each contained
my **step-by-step** instructions
on how to solve
an initial-boundary value problem

of calculus.
Massively parallel supercomputing
was called a grand challenge
for the good reason
that it was impossible
to harness its potential.
A novelist or a science fiction writer
can solve problems with the pen.
But I cannot buy a billion dollar
supercomputer
with a mere waive of the pen.
It’s even more difficult
when you’re black and African
and conducting scientific research
as a lone wolf
in Los Alamos, New Mexico, United States.

45.3.2 Calculus and Supercomputing

Calculus
is the most common denominator across

every supercomputer 2159
that computes in parallel.
Nine in ten supercomputer cycles
are consumed and used to solve
computation-intensive problems
that had their roots in calculus.
I studied calculus
in June 1970 in eighth grade
at Christ the King College,
Onitsha, Nigeria.
Because I stood out
for studying calculus in eighth grade,
everybody at Christ the King College,
called me "Calculus."
And nobody at Christ the King College
called me "**Philip Emeagwali**."
I programmed sequential processing
supercomputers
on June 20, 1974
at 1800 SW Campus Way,
Corvallis, Oregon, United States.

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I invented
how to harness a new internet
that is a global network
of 64 binary thousand
processors.
I invented
how to harness that new internet
and use it to execute a set of floating-point
arithmetical problems.
Those arithmetical problems
arose from
a system of equations
of algebra.
Those algebraic problems
arose from
a system of partial differential equations
of calculus.
Those partial differential equations
arose from
a set of laws of physics.
And those laws of physics

describe the precise motions 2161
that were **coded** as algorithms
and **encoded**
into general circulation models.
And general circulation models
are used to **foresee**
otherwise **unforeseeable** global warming.
In September 1981
I was living in Silver Spring, Maryland,
studying in both Washington, D.C.
and College Park, Maryland,
and conducting supercomputing research
in Silver Spring, Maryland.
I had spent the prior seven years
programming supercomputers.
For my growing knowledge
of supercomputing,
I was perceived
as a growing intellectual threat.

As a black and African immigrant
in the United States,

I was **banned** 2162
from programming the Cyber 205
vector supercomputer.
Research nuclear scientists
from [quote unquote]
"a list of unfriendly countries"
were also **banned**
from programming the Cyber 205
vector processing supercomputer.
The United States Congress was afraid
that nuclear scientists
from North Korea
could acquire the expertise
it takes to solve
the system of coupled,
non-linear, time-dependent,
and state-of-the-art
partial differential equations
of calculus
that governs the motions
of the shock waves

that emanates 2163
from nuclear explosions.
The denial of access
to U.S. supercomputers
forces the North Korean government
to explode its nuclear weapons,
instead of secretly simulating
nuclear explosions.
That Cyber 205
vector processing supercomputer
that I was banned from programming
was purchased by the United States
National Weather Service.
That agency was part of the
National Oceanic and Atmospheric
Administration.
That vector processing supercomputer
was used to solve the primitive equations
of meteorology.
The primitive equations
were a system of coupled, non-linear,

time-dependent, and state-of-the-art 2164
partial differential equations
that were hyperbolic.
To quote myself
from an advanced calculus lecture
that I gave in 1981
in Washington, District of Columbia,
United States:
“The dependent variables
of the primitive equations of meteorology
include the temperatures,
the speeds, and the pressures
of the air and moisture
that flows above the surface of the Earth.
A supercomputer is needed
to solve for those dependent variables
and to compute them
at several levels of the Earth’s atmosphere.”
The Cyber 205
vector processing supercomputer
that I was **banned** from programming,

back in 1981, 2165
evolved into the ETA-10 supercomputer.
And because I was **banned** from
programming vector processing
supercomputers
I **involuntarily**, but fortunately,
evolved into the lone wolf programmer
of the most massively parallel processing
supercomputer
ever built.
A decade later and in 1991,
I crossed paths with the Cyber 205
vector processing supercomputer
that I was banned from programming
back in 1981.
I lived across the street
from the head office
of ETA Corporation
that was within Energy Park
and adjacent to Bandana Square,
Saint Paul, Minnesota, United States.

Back in 1981, the Cyber 205 2166
that I was **banned** from programming
was a vector processing supercomputer
that was housed at
the National Meteorological Center
in Camp Springs, Maryland.
The National Meteorological Center
is the **forecasting heart**
of the National Weather Service.
In the 1980s, twenty-five thousand [25,000]
scientists
were allowed to program
vector processing supercomputers.
I was not one of those 25,000 scientists.
Instead, I was **relegated**
to conducting my supercomputer research
alone.
I computed alone
and coded in cold basement labs.
In the world of supercomputers,
I had to experimentally discover

that the **impossible**-to-compute is, in fact, 2167
possible-to-compute.
Twenty years later,
and in a White House speech televised
on August 26, 2000,
then President Bill Clinton
acknowledged my contributions
to the development of the supercomputer
that computes in parallel
and that is the pre-cursor
to the modern supercomputer.
In the 1970s and '80s,
parallel processing
was ridiculed
as a huge waste of everybody's time.
The lesson that I learned
from being exiled
from the world of supercomputers
was that closing the door
to the **known** world of
vector processing supercomputers

opened the door
to the **unknown** world of
parallel processing supercomputers.
I learned that
when one door closes
another door opens.

45.4 Philip Emeagwali's Contributions to Calculus

45.4.1 Philip Emeagwali and Modern Calculus

In 1989, that contribution to calculus
was the reason
a 15-year-old writing a school report
on the development of modern calculus
asked me to explain the
"contributions of Philip Emeagwali
to modern calculus."
I explained that my mathematical quest
was for the most important
and the most advanced calculus

that could be discovered
at the uncharted territory of
partial differential equations of calculus.
It was in that unknown world of calculus
that I invented
a system of nine
partial differential equations
of calculus
that are known as
Philip Emeagwali's equations
that are coupled
and, therefore, must be solved
simultaneously,
that are non-linear
and, therefore, are impossible
to solve directly,
that are time-dependent
and, therefore,
will be more computation-intensive
to solve on a supercomputer,
and **that are** hyperbolic,
instead of parabolic
as described in calculus textbooks.

I originally formulated 2170
my system of equations
for the blackboard
and defined each at **infinite** points
in space and time.
Then I discretized and reformulated
my system of equations of calculus
and re-defined each
partial differential equation
at **finite** points
in space and time.
That discretization
of partial differential equations
and their reformulation
and approximation
as algebraic equations
gave rise to my large-scale system of
equations of algebra
that could be computationally solved
by step-by-step instructions
that are a finite number of
floating-point arithmetical operations.
I invented

how to solve 2171
that extreme-scale problem in algebra
and I invented how to computational solve
that tough problem
on a motherboard
or invented how to experimentally solve that
floating-point arithmetical problem
across a new internet.
I invented that new internet
as a new global network of motherboards
or processors
or computers.
I coded my system of equations
of algebra
and solved that system
as a set of floating-point
arithmetical operations.
In 1989, it made the news headlines
that a 35-year-old
African supercomputer wizard
born in Akure, Nigeria
and living in the United States
had invented

how to execute those
floating-point operations
and execute them **across**
a new internet
that he invented
as a new global network of
64 binary thousand processors.
I—**Philip Emeagwali**—was that
African supercomputer wizard
that was in the news back in 1989.
I invented
how to solve
24 million equations of algebra
that was a world record in 1989.
I invented
how to solve the most large-scaled
algebraic problems
and how to solve them
at the fastest speeds of
arithmetical computation
and email communication
that could be recorded **across**
a new internet

that is a new global network of
64 binary thousand
commonly available processors.
My quest was for new knowledge in calculus
—or for never-before-seen
Philip Emeagwali's
partial differential equations—
and for how to
approximate Philip Emeagwali's
new calculus
as the **largest-scaled algebra**
and use that algebra
as the mathematical foundation
of my large-scale
computational fluid dynamics codes.
I executed those computation-intensive
codes across
a new internet.
I invented that new internet
as a new global network of
64 binary thousand
processors,
or a global network of

as many computers that are distributed equal distances apart and distributed across the surface of a globe in a sixteen-dimensional universe. 2174
That new internet
that is a supercomputer
de facto
that I invented
is to calculus
what the **telescope** is to **astronomy**
or the **microscope** is to **biology**
or the **x-ray machine** is to **medicine**.
Back in 1974 and '75,
my research interests were in astrophysics,
not in supercomputers.
In 1974, the supercomputer
was only a hobby to me.
By 1975, I had taken all the astronomy
courses offered within the state of Oregon.
However, it was my mentor,
Fred Merryfield,
that advised me to switch from

astronomy to engineering. 2175
There were more jobs in engineering
than in astronomy,
but ironically, my first job offer
was to be an **astronomer**
in Washington, DC.
Fred Merryfield was a man of means
and I was living with him and his wife,
Anne,
in 1975 and '76
and at 2540 SW Whiteside Drive,
Corvallis, Oregon.
In 1946 and the year
the programmable computer was invented,
Fred Merryfield
founded the top engineering firm,
CH2M.
In our series of after dinner conversations,
Fred Merryfield
remotely and subconsciously teleguided me
from the astrophysics of distant stars
to the geophysics of planet Earth.
That's how I acquired expertise

in terrestrial and engineering physics 2176
such as hydraulics, hydrology, meteorology,
oceanography, and fluvial geomorphology.
In my few years of insanity,
I switched from the physics of the heavens
to the geophysics
and the large-scale
computational fluid dynamics
of the earth, air, and sea.
But I had to first travel across
the unknown world, or the *terra incognita*
of extreme-scale computational physics
and the *terra incognita*
of partial differential equations
of calculus
and the *terra incognita*
of large-scale algebra.
I had to travel those frontiers
before I could travel across
the *terra incognita*
that was my global network of
64 binary thousand
processors

that were braided together
as one cohesive whole computer
and braided together
by one binary million email wires
and braided together as a new internet.
What helped me in my quest
for the fastest supercomputer
was that I was on the right path,
despite my numerous **zig-zags**
and **side detours**.
After the first rough decade,
I saw a light
—and saw a new internet—
at the end of my dark tunnel
that was a new global network of
commodity-off-the-shelf processors
that were identical,
that were equal distances **apart**
and with each processor
operating its own operating system
and with each processor
having its own dedicated memory
that shared nothing with each other.

How to use that massively
parallel processing supercomputer
and how to use that new technology to **solve**
otherwise **unsolvable** problems,
such as **initial-boundary value problems**
at the frontier of modern calculus
is the reason 15-year-olds
are writing school reports on the
"contributions of **Philip Emeagwali**
to modern calculus."

45.5 Philip Emeagwali's Equations

45.5.1 Closing—Modern Calculus

To the non-mathematician,
my mathematical inventions
are dense, **abstract** and **invisible.**
The system of nine coupled, non-linear,
and time-dependent
partial differential equations
of the modern calculus

that I invented 2179
were described by mathematicians
and for mathematicians
and was the cover story
of the May 1990 issue
of *SIAM News*.
In the June 1990 issue of *SIAM News*,
a research computational mathematician
wrote that:

[quote]
"I have checked
with several reservoir engineers
who feel that his calculation
is of real importance and **very fast**.
His explicit method
not only generates lots of megaflops,
but solves problems **faster**
than implicit methods.
Emeagwali is the **first**
to have applied a pseudo-time approach
in reservoir modeling."
[end of quote]

The *SIAM News*
is the bi-monthly publication
of the Society for Industrial
and Applied Mathematics,
which is the premier society
for mathematicians.
The *SIAM News*
is where newsworthy
partial differential equations
of modern calculus
are published
and presented to the foremost experts
in modern calculus.
My contribution to mathematics
is this:

In the 1970s and ‘80s,
I correctly reformulated
the Second Law of Motion
of physics
that was discovered
330 years ago.

I correctly reformulated that law
and correctly encoded it
into the most advanced expressions
in calculus.
Those calculus expressions
consisted of eighty-one [81]
partial derivative terms
that encoded the motions
of crude oil, injected water, and natural gas
in the x-, y-, and z-directions,
that comprised of
forty-five [45]
partial derivative terms
that were in advanced calculus textbooks
plus the thirty-six [36]
partial derivative terms
that I invented
and that were **not**
in any calculus textbook.
Put differently, the cover story
of the May 1990 issue
of the *SIAM News*,
that is the number one publication

for new mathematics,
described the system of **nine**
coupled, non-linear, time-dependent,
and state-of-the-art
partial differential equations
that I invented
and that is my contribution
to modern calculus.
Those nine Philip Emeagwali's
partial differential equations
that I invented
are akin to the system of
partial differential equations
that is **cross-listed**
in the seven millennium problems
of mathematics
and that is one of the seven
toughest problems
in mathematics.
My grand challenge in supercomputing
was to invent
how to make the **impossible-to-compute**
possible-to-compute

and to do so by experimentally discovering 2183
massively parallel processing
that makes modern computers faster
and makes the new supercomputer
the fastest.
I invented
how to solve that Grand Challenge problem
of computing
that is the toughest problem
in calculus.
I invented
how to solve that tough problem
by mathematically inventing
how to compress those
system of **partial differential equations**
that were defined
in the interior of the domain
of an **initial-boundary value problem**
and compress them
into their equivalent algebraic equations
and, finally, how to email equal portions
of those algebraic equations
to my 65,536

commodity-off-the-shelf processors 2184
that I visualized
as **equidistant**
and that I visualized
as completely **encircling**
and **tightly circumscribing**
a globe, or a hyper-globe,
in a sixteen dimensional hyperspace.

45.5.2 Closing—Modern Calculus

The abacus was invented
3,000 years ago
and invented in ancient China.
In his book titled
“Natural History,”
the Roman author Pliny the Elder
explained that the breadth of Asia
should be "rightly calculated."
Pliny’s book was written in Latin
and was published
between the years 77 to 79,

or about two thousand years ago. 2185
The Latin translation for the phrase
"rightly calculated"
is "*sane computetur*."
In that sense, the word "computer"
was first used 2000 years ago.
Calculus
was invented 330 years ago.
The phrase "partial differential equation"
was first used in 1845.
A century and one year later,
the programmable computer
was invented in 1946
and was invented
for solving the
ordinary differential equation
that govern the motions
of ballistics.
The technology called
parallel processing
that powered a new internet
that is a new global network of
65,536 programmable processors,

or a new global network of as many programmable computers, 2186
was invented
in 1989.
I—**Philip Emeagwali**—
was the lone wolf supercomputer programmer
that invented that new internet
and programmed the processors
within that new internet
to compute together
as one cohesive, seamless supercomputer
that is the precursor
of the modern supercomputer
that can solve a system of coupled,
non-linear, time-dependent,
and state-of-the-art
partial differential equations
of modern calculus.
I invented nine of those
partial differential equations,
called Philip Emeagwali's equations.
I invented

how to use parallel processing 2187
and how to use the technology
to **recover** otherwise **unrecoverable**
crude oil and natural gas
and I invented how to use
the massively parallel processing
supercomputer
to **foresee** otherwise **unforeseeable**
global climate change
and how to use the
massively parallel processing
supercomputer
to compress 65,536 days,
or 180 years, of **time-to-solution**
of the most extreme-scale problems
arising in computational physics
and I invented how to **compress** that time
to just one day of **time-to-solution**
across a new global network of
65,536 commonly available processors
that outline a new internet
that is also a new supercomputer.

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