2 Biggest Advance Since Newton, Galileo—Part 2

How I Began Supercomputing

My supercomputing quest
was to make the fictional factual.
In 1989, I was in the news headlines
because
I made the fictional
massively parallel processing supercomputer
that I hypothesized
back in 1974
and made the technology factual
and constructively reduced
my ensemble of processors
to the precursor
of the modern supercomputer
that I experimentally discovered
on the Fourth of July of 1989.
I began supercomputing

from the realm of science fiction.
I began supercomputing
from the realm of an ensemble of
fictionalized
two-to-power sixteen processors
that were married together
as one cohesive internet
and married by sixteen times
two-to-power sixteen email wires
that encircled a globe
in a sixteen-dimensional hyperspace.
I began supercomputing
not as a supercomputer scientist, *per se*,
but as a mathematician
that was more at home with
non-Euclidean geometry and topology
than with a single processor.
I began supercomputing
as a mathematical physicist
that was exposed to the

four-dimensional **space time-continuum**
of Albert Einstein's Theory of Relativity.

Early Controversies in Supercomputer World

In the decades of the 1960s
through '80s,
parallel processing
was the subject of a titanic battle
between the **majority**
who believed that all supercomputers
should be powered by
a single, isolated processor
and the **minority**
who believed that all supercomputers
should be powered by
an ensemble of thousands of processors.
In the 1970s and '80s, parallel processing
was embroiled in controversies
and countless ridiculing statements
were made about the technology.
That was the reason

only one computational mathematician
attended my public lecture
on **parallel processing**
that took place in November 1982
and took place in a lecture auditorium
that was a short walk
from The White House, Washington, D.C.

A Hero's Welcome, After 9-Year Rejection

Nine years later, my lecture
on **parallel processing** supercomputing
that I gave on July 8, 1991
in Washington, D.C.
was before a **standing** room only audience
of research computational mathematicians
that were attending
the largest international congress
of mathematics.
The top one percent of mathematicians,
or ten thousand research mathematicians,
read about my mathematical discoveries

and my contributions
of new calculus
and new algebra
to mathematical knowledge
and read about my mathematical discoveries
through the cover story
of the May 1990 issue
of the *SIAM News*,
that is the bi-monthly news journal
of record
of the mathematics community
that is published
by the Society of Industrial
and Applied Mathematics.
I was not on the cover of
the top mathematics publications
because I was good looking.
I was on the cover of
the top mathematics publications
because I contributed to mathematics.
And at the end of each research lecture

that I gave on my discoveries
in extreme-scale
computational mathematics,
the audience rose as one
to give me a standing ovation
and they did so because I displayed
the **command of my materials**
that, in turn, could only come
from a deep bench of ideas and knowledge.
I discovered
how to massively parallel process
and how to compute **across**
a new internet
that's *de facto* a new supercomputer
that's a global network of
64 binary thousand
commodity-off-the-shelf processors.

Supercomputing Across a New Internet

The core essences
of my computational experiments
were to email questions and answers
that pertained to those equations
and algorithms,
that pertained to those
partial **differential** equations
of modern calculus
and computational physics
and partial **difference** equations
of modern algebra
and that were generated
within each of my 65,536
commodity-off-the-shelf processors
on my new internet
that had sixteen orthogonal pathways
and that were identical to each other
and that were equal distances
afar and **apart**
from each other
and to email each processor

via email wires
that metaphorically
had a one-to-one correspondence
to the 1,048,576
bi-directional edges of the cube
in a sixteen-dimensional universe
that I visualized as etched
onto the surface of a sphere
in a sixteen dimensional universe
and visualized
as a new global network processors
and email wires
that had no center, no edge.
My data
circulated endlessly
and circulated towards the
everlasting infinity
of a new internet
that had centers everywhere,
circumference nowhere.
Those emails delivered my

65,536 computational physics codes
and delivered them
to 65,536 processors
of my new internet
that had a **one-to-one** correspondence
to the two-to-power sixteen,
or sixty-four binary thousand,
or 65,536, vertices
of the same hypercube in hyperspace.
My new internet
is my river of knowledge
that has **1,048,576** bi-directional tributaries
that fed arithmetical data
into **65,536** electronic brains.
To me, **Philip Emeagwali**,
my theory was a metaphor
for the lyrics or screen play,
while my experiments
represented the song or play.
I had the visceral feeling
that I wrote the screen play

of a computational physics movie
with sixty-four binary thousand physicists,
each a metaphorical dancer,
that metaphorically danced **across**
one binary million pathways
that outlined a new internet.
I had the visceral feeling
that I was the dance choreographer
that acted in his production,
which in my reality
was a movie
that is a petroleum reservoir simulation
of extreme-scale computational physics.
I visualized my 65,536
computational physics codes
as metaphors for as many screen plays.
If printed on paper,
my screen play would weigh
eighty million pages
of arithmetical data!

As a research massively parallel processing
computational mathematician,
one of my basic premises
was that each partial differential equation
of mathematical physics
must be **congruent**
with the law of physics
it encodes
and must not be **contradictory**
to the law of physics
that it arose from.

Rejections in the 1970s and '80s

To many white historians of science,
a black inventor is a myth
until he becomes a white inventor.
I've sat for a published portrait
in which the white illustrator portrayed me

as a white inventor
and did so
to make me acceptable
to his white readers.
The reason my invention was rejected
was that it was dismissed
as a black invention and as a myth.
I was mocked at
not because my theory
and its companion
parallel processing experiment
was wrong.
I was mocked at
because I was a lone wolf, black, and African
supercomputer scientist
that was trying to prove that
the impossible-to-solve
is, in fact, possible-to-solve.
To some white research mathematicians,
I was trespassing
in a space—a mathematical

terra incognita—that wasn't mine.
In the 1970s and '80s,
my mathematical discovery story
—that became the cover story
of top mathematics publications—
was ridiculed, mocked, and rejected.
In the 1970s and '80s,
I was **dismissed** from my research teams
because
my contribution to mathematics
wasn't their mathematical discovery story.
In the 1970s and '80s,
I was rejected and mocked
because I proposed that
parallel processing will work, namely,
that an ensemble
of the slowest processors
in the world
could be harnessed to compute faster than
the fastest supercomputer
in the world.

In the 1970s and '80s,
my massively parallel processing
supercomputing premise
was that
the logic of the grand challenge problem
should determine how the problem
should be solved,
not vice-versa.
That is, it's only the laws of logic
and physics
that are **sacrosanct**,
not the technology
that, in the first place,
must bend for the laws of logic and physics.
In November 1982, I stood up to speak
in a conference auditorium
that was a short walk
from The White House, Washington, DC.
When I stood up to speak
about my research
on the massively parallel processing
supercomputer

that is the precursor
of the modern supercomputer,
every computational mathematician
in the auditorium,
except one young
computational mathematician,
stood up and left the auditorium.
The seminar invitations
that I received in the 1980s
came from American scientists
who did not know—in advance—
that I was young, black, and African.
Often, I was invited
and then **disinvited**.
I was invited to deliver
research seminars
based on their assumption
that I was a white mathematician.
I was often disinvited
when they discovered
that I was black.

Each time my lecture was cancelled,
I felt I was the wrong person
with the right message.
In the 1970s and '80s,
I was a lone wolf
supercomputer scientist because
white American research
supercomputer scientists
that agreed—on the telephone—
to collaborate with me
withdrew their offer
after they discovered
that I was black and African.
Often, your ideas that get rejected
when you're young
could lead to discoveries
that wins you awards
when you're old.
Some of those supercomputer scientists
that rejected my experimental discovery

of the massively parallel processing supercomputer,

and rejected it back in the 1970s and '80s,
have seen their children and grandchildren
write a school report
on my discovery that they rejected.

Emeagwali's Equations

My system of coupled, non-linear,
and time-dependent
partial differential equations
of modern mathematics,
called Emeagwali's Equations,
were developed only for
research computational mathematicians.
I told mathematicians attending
the 1991 International Congress
of Industrial and Applied Mathematics,
the following:

"As a research mathematician
and as a research physicist,
I always knew the fact
that the scientific discoverer
discovered a truth,
whereas the inventor
of a partial differential equation
formulated possibilities."

Searching For the New Supercomputer

To invent a new supercomputer
is to make the **impossible-to-compute**
possible-to-compute.
To discover
is to see something that was previously
unseen.
A scientist on a re-search for new knowledge
is a truth seeker that is seeking
new truths.
A supercomputer scientist

on a re-search for a faster supercomputer
is seeking a new supercomputer
and is seeking new computer.
The discoverer
becomes the first truth seeker.
The scientific re-searcher
is on her hero's quest
for the previously unseen truth.
Our never-ending quest
for the fastest possible supercomputer
has become our journey
to the frontier of human knowledge.
That never-ending quest
has become a self-directed evolution
in which we are both the creator
and the created.
That journey to the end of knowledge
will force our post-human descendants
of **Year Million**
to know the answer to the larger question
of who we are
and where do we want to go.
Back in June 1990, **Steve Jobs**

was looking for a new direction.
Steve Jobs
was intrigued by my experimental discovery
of how and why parallel processing
across a global network of
65,536 processors,
or **across** a new internet,
reduced 65,536 days, or 180 years,
of **time-to-solution**
on only one processor
that is not a member
of an ensemble of processors
to just one day of **time-to-solution**
across a new internet
that is a global network of
65,536 commodity-off-the-shelf processors.

Paradigm Shift in Supercomputing

I visualized my new internet
as encircling a globe, or a hyperglobe,
in hyperspace.

I visualized my new internet
as a global network of
64 binary thousand processors
that are equal distances
afar and **apart**
and on the surface of a globe
in a sixteen-dimensional hyperspace.
Leapfrogging upwards
from the third dimension in space
into the sixteenth dimension in hyperspace
leaves the non-mathematician to wonder:
where did the extra thirteen dimensions
come from
or go to?
On my motherboard,
the extra thirteen orthogonal dimensions
were compressed into the depth,
height, and width directions.
That experimental discovery
is my contribution
to the development

of the first internet
that emulated the fastest supercomputer
and that could be harnessed to
massively parallel process
across an ensemble of 65,536 processors.
My experimental discovery
of the massively parallel processing
supercomputer
that occurred
on the Fourth of July of 1989
changed the way we think about
the new supercomputer
that is the fastest computer
that should become
the computer of tomorrow.
My experimental discovery
of massively parallel processing
opened the door
for the biggest paradigm shift
in extreme-scale computational physics.

That experimental discovery
of massively parallel processing
garnered international headlines
and I the story teller
became the story
and the subject of school reports titled:
"The Contributions of **Philip Emeagwali**
to the Development of the Computer."

Crossing New Frontiers of the Supercomputer

The uncharted fields of knowledge
is the new land
to be explored and colonized.
That new land is explored
the way **Mungo Park** explored
the River Niger of West Africa.
The exploration of **Mungo Park**
opened the door
for Great Britain

to colonize my country of birth, Nigeria.
I'm the **Mungo Park**
of the supercomputer world
that was searching
for the fastest computation, **ever.**
I was searching
for the **new supercomputer**
that computes in parallel,
instead of in sequence.
In the 21st century, Africa
must cross new frontiers
of technological knowledge
to conquer today's challenges.

How the Supercomputer Benefits You

Since my experimental confirmation
of parallel processing
that occurred
on the Fourth of July of 1989,
I am often asked

to explain how parallel processing
benefits you.
That's like asking:
"What will the world be like
without parallel processing?"
A world without parallel processing
is a world
in which ninety-nine [99]
of the one hundred [100] processors
inside your computer
is turned off
and you're computing
at one percent
of your computer capacity
and perhaps, achieving only one percent
productivity level.
A new supercomputer
without parallel processing
is reduced to the stature
of an ordinary computer.
A new supercomputer

that is not parallel processing
is like Lagos (Nigeria)
with only one street light on.
The **fastest** supercomputer
costs the budget of a small nation
and it is purchased
because the **fastest** supercomputer
gives meaning to life,
and because the **fastest** supercomputer
makes the world a better place,
and because the **fastest** supercomputer
makes humanity more knowledgeable
and because the **fastest** supercomputer
of today
will become the computer of tomorrow.
The scalar processing supercomputer
helped the first man
that traveled to the moon
to return safely from the moon.
The vector processing supercomputer
helped man fly faster
and helped the first woman
that traveled into outer space

to return safely from outer space.
The parallel processing supercomputer
will help the first humans
that will travel to the planet Mars
to return safely
from the planet Mars.
And **faster** supercomputers
is where science fiction
will become non-fiction.
The **fastest** supercomputer
is where humanity's future
takes shape.
Parallel processing
has taken the computer
into a new era.

Father of the Modern Supercomputer

An invention
differs from an engineering project.
Constructing a bridge or a car or a computer
or the internet
is merely an engineering project

that employs
more than a thousand pair of hands.
But **faster** computers
and the **fastest** supercomputers
could not be manufactured
without the invention
of the technological knowledge
of **faster** computers.
I'm not the technician
that unpacked the crates
of the new supercomputer.
I'm not the technician
that installed
the internal computational components
of the new supercomputer.
Nor am I the technician
that installed
the internal networking components
of the new supercomputer.
And I'm not the technician
that hooked those components
into the cooling and power infrastructures
for the new supercomputer.

However, I'm called the father
of the new supercomputer
because I experimentally discovered
how and why the technology
of massively parallel processing
across a new internet
makes the new supercomputer fastest.
Parallel processing
was ridiculed, mocked, and rejected
by **Gene Amdahl** and **Seymour Cray**,
the two pioneers
of the old sequential processing
supercomputer
and the old vector processing
supercomputer, respectively.
I was ridiculed, mocked,
and disparaged as the bush fowl
that crowed
in the language of another village.
Parallel processing
was only accepted
after decades of protracted

and strenuous conflicts
against the likes of **Gene Amdahl,**
the supercomputer boss at IBM Corporation
and **Seymour Cray**, who designed
seven in ten vector processing
supercomputers sold in the 1980s.

The Moment I Invented a New Supercomputer

At 10:15 a.m. Tuesday
the Fourth of July of 1989,
the US Independence Day,
I made the first experimental measurement
of the world's fastest computation
ever recorded **across**
an ensemble of processors
that is a new internet.
That experimental discovery
represents a new way
of looking at the computer.
To be the first

is a greater achievement
than to be number one
or to be the fastest.
There's only one first
but they will be many fastest.
I was the first to discover
that parallel processing **across**
an ensemble of the slowest processors
is faster than sequentially processing
only on the fastest processor,
or only on the fastest supercomputer.
It was my most pleasurable experience
to be the first-person-ever
to stand at the farthest frontier
of human knowledge
and experimentally discover
the massively parallel processing
supercomputer
that is the precursor
to the modern computer.
On the night of the Fourth of July of 1989,

I had a powerful, unsettling dream.
I woke up with the visceral feeling
that I had permanently entered
into the history book
and into school reports.

From Parallel Processing to the Supercomputer

In 1989, I won the top award
in the field of supercomputing
and it made the news headlines that
a lone wolf African
supercomputer genius
in the United States
has brought that
figment of the imagination
—called parallel processing—
and brought the technology
from dream to reality.
Today, parallel processing
is in the history book

and is the reason the 12-year-old
is writing her school report
on the life of **Philip Emeagwali**
and his contributions
to the development of the computer.
I experimentally discovered
how to solve
the grand challenge problem
of supercomputing
that had cast its ominous shadow
over the first 43 years
of the invention
of the programmable supercomputer
that was invented
back in 1946.
That experimental discovery
represents a new paradigm
in the history of the computer.
The experimental discovery
was the **tipping point**
that lead to the complete acceptance

of the massively parallel processing
supercomputer.
That experimental discovery
of massively parallel processing
was immediately embodied
into all modern supercomputers
and is now universally used
within most modern computers.
That experimental discovery
was the new knowledge
that convinced the naysayers
to change the way they looked at
the modern supercomputer.

Fourth of July of 1989: A Retrospective

Looking back since ancient times,
computing aids have improved
from the dust-board
to the blackboard
to the motherboard and, now, **across**

motherboards,
or **across** a new internet.
When you're inventing something
that thing is yours.
When you've invented that thing,
you give that thing to posterity
and that thing is no longer yours.
I believe that, for thousands of years,
the massively parallel processing
supercomputer
will be remain at the essential core
of the science of computing.
I believe that the supercomputer
will remain an extension of humanity
and that massively parallel processing
around the planetary-sized Internet
will be passed from
civilization to civilization.
I believe that
massively parallel supercomputing
will be an intrinsic part of
man-made brains

of our post-human descendants
of Year Million.

My Eureka Moment

My moment of experimental discovery
was 10:15 a.m. the Fourth of July of 1989.
At 10:15 a.m., I witnessed the birth cry
of a new computer
that is a new supercomputer
that is a new internet
that is outlined
as a global network of
65,536 processors.
I saw something
no human had ever seen before.
I saw an ensemble
of the slowest processors
in the world
outperform the fastest supercomputer
in the world.
I got goose bumps

and my hairs stood straight
while I watched that discovery.
Seeing, for the first time ever,
the **slowest** processors compute together
to compute faster than
the **fastest** supercomputer
was the most amazing experience
in my life.
I was witnessing
the birth of a new era
in the history of the computer.
I was witnessing
a paradigm shift
in the supercomputer world.
I was witnessing
a change of tectonic proportion
that will be a change
in the way we think about the computer.
I was gazing **across** the centuries.
The Fourth of July of 1989
was the moment
we changed the way we look at
the supercomputer.

The Fourth of July of 1989
was the moment
that for the first time ever
an ensemble of the slowest processors
computed together
and computed as one seamless, cohesive unit
and computed faster than
the fastest supercomputer.
For me, Philip Emeagwali,
the Fourth of July of 1989
was the day of fire,
the day the massively parallel processing
supercomputer
became the fire we can't put out.
After my experimental discovery
of the Fourth of July of 1989,
trying to stop the acceptance of
the massively parallel processing
supercomputer
became like trying to stop midnight.

A New Computer Science

My **experimental discovery**,
of the massively parallel processing
supercomputer
that occurred
on the Fourth of July of 1989, that occurred
across a new internet
that is a new global network of
64 binary thousand processors
opened the door
to the state-of-the-art new supercomputers
that now computes
10 binary million times faster.
That new supercomputer, in turn, creates
a new computer science.
Before my discovery,
or in the 1980s or earlier,
the one thousand fastest supercomputers
in the world
computed with only one

processor.
After my discovery,
or after the Fourth of July of 1989,
the one thousand fastest supercomputers
in the world
parallel processed and computed
with thousands or millions
of commodity-off-the-shelf processors.
The **paradigm shift**
was from computing and communicating
in the singular
to doing both in the plural senses.
On the Fourth of July of 1989,
I witnessed the unveiling
to the human race
of a new understanding of the words
"**computer**" and "**supercomputer**."
In the old dictionary,
the computer
was powered by only one processor
that was not a member of

an ensemble of processors.
In my new dictionary,
my computer
was powered by my ensemble of
65,536 commodity-off-the-shelf processors
that cohesively computed
as one seamless supercomputer.
The computer
is the greatest invention
of the 20th century.

Making the World Better

In 1989,
I was in the news
for experimentally discovering
how to harness the massively
parallel processing supercomputer
and how to use the technology
to reduce the **time-to-solution**
for solving

extreme-scaled system of equations
of **algebra**
and how to reduce that **time-to-solution**
from 180 years, or 65,536 days,
to only one day of **time-to-solution.**
I was in the news because
reducing that **time-to-solution**
increases the odds of
discovering and recovering
otherwise undiscoverable and unrecoverable
oil and gas.
The June 27, 1990 issue
of *The Chronicle of Higher Education*
Wrote that I—**Philip Emeagwali**—
[quote]
"took on an enormously difficult problem."
[unquote]
That **enormously difficult problem**
that I solved
is the toughest problem in calculus.
That *Chronicle of Higher Education* article
continued that **Philip Emeagwali**
[quote]

"solved it alone,
has won computation's top prize,
captured in the past
only by seasoned research teams."
[unquote]
That *Chronicle of Higher Education* article
continued that:
[quote]
"If his program can squeeze out
a few more percentage points,
it will help decrease
U.S. reliance on foreign oil."
[unquote]
A discovery is like a stone
thrown into the pool of knowledge.
The discovery
generates wider ripples
each time we throw it
into the pool of knowledge,
or apply it.
The discovery in science
open up doors in technology

and makes the world a better place
and a more knowledgeable place.
We cannot see, hear, or feel
the subterranean motions of the oil and gas
that are flowing one mile deep
underneath our feet.
The supercomputer simulation
of the subterranean motions
of the oil and gas
that are flowing one mile deep
enables the petroleum geologist
to see—with his digital eyes—
the flow patterns
of the oil and gas
that are invisible to our naked eyes.
The parallel processing supercomputer
that can be programmed to solve
the trillions upon trillions
of equations of **algebra**
that arises
from the **extreme-scale**
petroleum reservoir simulator
is the new age divining rod

that must be used
to discover and recover
otherwise undiscoverable and unrecoverable
oil and gas.
The parallel processing
computational physicist
can intellectual see
within a massively parallel processing
supercomputer
and see oil and gas
that we cannot see
with biological eyes.
The parallel processing
computational physicist
that mathematically sees
deep inside the Niger-Delta oilfields
of Nigeria
enables us to discover and recover
otherwise undiscoverable and unrecoverable
oil and gas.
Oil and gas
are at the core essence
of Nigeria's **sovereignty** and identity.

Changing the Way We Look at the Computer

In 1989, it made the news headlines
that I experimentally discovered
how we can use our parallel processing
supercomputer eyes,
or use a new internet,
that is a global network of processors,
as our instrument of physics
as well as use the technology
as our tool for oil and gas exploration.
Conversely, if the petroleum industry
didn't accept my invention
and didn't harness
my ensemble of 65,536, or more,
commodity-off-the-shelf processors
and didn't use them
in their petroleum reservoir simulations,
then less oil and gas
will be discovered and recovered.

My experimental discovery
of massively parallel processing
changed the way
the petroleum industry **discover**
and **recover**
otherwise undiscoverable
and unrecoverable oil and gas.
My experimental discovery
of how and why parallel processing
makes
the modern supercomputer **fastest**
changed the way
we think about how to build
the **fastest** computer.
It made the news headlines,
in 1989,
when I experimentally discovered
that we could execute
extreme-scale computational physics codes
and execute them **across**
an ensemble of 65,536

commodity-off-the-shelf processors
that were **identical** to each other
and that were equal distances
afar and **apart**
and that I visualized
as a new internet
that encircled a globe
in sixteen-dimensional hyperspace.

After the Discovery Was Made

The massively parallel processing
supercomputer
that I experimentally discovered
on the Fourth of July of 1989
cannot be undiscovered.
Therefore, a supercomputer scientist
that is beginning his quest
for the massively parallel processing
supercomputer
and beginning that technological quest

today
is like the person that shows up to a party
after half the guests
have left
and the other half
is getting ready to leave.
That experimental discovery
made the news headlines
in 1989
because it was the first
successful and noteworthy calculation
to be executed
across an ensemble of 65,536 processors
and executed
in a manner that demonstrated
that the technology of the
massively parallel processing
supercomputer
is not a huge waste of time.
My discovery is the reason
one in ten supercomputers

are purchased by the petroleum industry.
The necessity
to execute extreme-scaled problems
arising in computational physics
is one of the technological grand challenges
that **stimulated**
the development of the
massively parallel processing
supercomputer.
Parallel processing
is the paradigm shift of tectonic proportions
in the history of computing
that changed the way
oil and gas are discovered and recovered.
The most important contribution
of the extreme-scale computational physicist
that is parallel processing **across**
millions upon millions of
commodity processors
is to attain a surer and deeper understanding
of how the universe works

and how to harness that new knowledge
to make planet Earth
a better place for human beings
and for all beings.

A World Without Supercomputers

A world without the massively
parallel processing supercomputer
is a world
in which fewer discoveries
are made,
is a world
in which innovation is slowed down,
is a world
in which human progress is slowed down,
and is a world
in which the computer of tomorrow
cannot be invented today
thus making it impossible
for us to create the future.

The bird sings the same song
as its **ma** and **pa**.
Human progress occurs
when we sing a better song
than our **ma** and **pa**.
For me, **Philip Emeagwali**,
my quest for the fastest computation **across**
a new internet
that was powered by two-to-power-sixteen
commodity-off-the-shelf processors
was *de facto*
the chant of a lone wolf massively
parallel processing programmer
that was hearing voices
from the sixteenth-dimensional hyperspace.
In the 1970s and '80s, I wrote voluminously
in my private supercomputer laboratory
notebooks
and I wrote with the hope
that my writings
will endure and survive

the ravages of the millennia and, hopefully,
become my tangible connection
to our post human descendants
of Year Million.