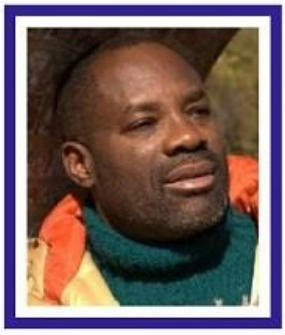
41 How I Solved the Toughest Problem in Calculus—Part 1 of 15 (A Black Mathematician and His Contributions to Calculus)



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41.1 They Call Me Calculus

41.1.1 Contributions to Calculus

The modern calculus
is a tool
that enables the mind
to go where the eyes cannot see.
Between the ancient laws of physics
and the modern laws of computing,
the partial differential equation
of calculus
is the pink elephant in the room.
Calculus
is the uncle nobody in the family
wants to talk about.
In 1989, I was in the news
for inventing
how to solve
the toughest mathematical problems
arising as the
partial differential equations

of modern calculus.
I was also in the news
for computationally inventing
how to solve
the largest system of equations
of algebra
that approximated that said
partial differential equations
of modern calculus.
I was also in the news
for experimentally inventing
how to solve the companion
initial-boundary value problems
and how to solve them
at the fastest speeds
and solve them **across**
a new internet
that I visualized
as my new global network of
64 binary thousand
tightly-coupled processors

that were identical,
that were equal distances **apart**,
and that shared nothing with each other.
I visualized my new global network
of commodity processors
as **married together**
by one binary million email wires
and **married together**
as one cohesive unit
that is my new supercomputer *de facto*.
I began my mathematical quest
by inventing nine
partial differential equations
of modern calculus.
My contributions to modern mathematics
was the cover story
of the May 1990 issue
of the *SIAM News*.
The *SIAM News*
is the top publication
for research mathematicians.

The *SIAM News*
is where newly discovered mathematics
is written by research mathematicians
for research mathematicians.
The *SIAM News*
is published by the Society of
Industrial and Applied Mathematics
that is the premier society
for research mathematicians.
The mathematical invention
that became the cover story
of the bi-monthly *SIAM News*
is to the research mathematician
what the cover
of *Sports Illustrated magazine*
is to the super model.
My cover story in the *SIAM News*
was akin to being inducted
into the **Hall of Fame** of mathematics.
I invented my nine
partial differential equations

of modern calculus
and I invented those equations from
the basic principle
called the Second Law of Motion
of physics.
The reason the geophysics origin
of my mathematical invention
should not come as a surprise
was that
the partial differential equations
of modern calculus
always arises from real-world problems.
My nine partial differential equations
arose from the problem of
using the **excruciatingly-detailed**
petroleum reservoir simulator
and using that code
to **recover** otherwise **unrecoverable**
crude oil and natural gas
that are flowing a mile-deep
inside the Niger-Delta oilfields

of southeastern Nigeria.
The reason I invented
the **Philip Emeagwali's** equations
and invented them from first principles
is that the Second Law of Motion
of physics
is assumed to be self-evident.
The Second Law of Motion
of physics
that was discovered
three centuries and three decades ago
is my starting point
and the physical foundation
of my contributions
to modern calculus
and extreme-scale algebra.
The reason
I was able to make that contribution
to calculus and algebra
was that I am a polymath,
not a mathematician *per se*.

Any research mathematician
who is not a polymath
and who is not at home
at the frontiers of knowledge
in physics and computer science
can only use, say,
the ordinary differential equations
of calculus
and use them
as both his starting and ending points.
I was a polymath
and a research supercomputer scientist
of the 1970s and ‘80s
who simultaneously conducted research
across the frontiers of physics,
mathematics, and computing.
I began my mathematical quest
for the fastest supercomputer
on Thursday June 20, 1974
at 1800 SW Campus Way,
Corvallis, Oregon, United States.

I began my quest
on the first supercomputer
in the world
to be rated at
one million theoretical instructions
per second.
I ended my quest
on Tuesday the Fourth of July 1989
in Los Alamos, New Mexico,
United States
and on the pre-cursor
to the modern supercomputer
that is the first supercomputer
in the world
to be rated at over
one billion actual calculations
per second.
The partial differential equation
of modern calculus
was the **common denominator**
between that first supercomputer

and the modern supercomputer.
At age fifteen and in Onitsha (Nigeria),
everybody called me “Calculus.”
In 1970, few people knew my name
“**Philip Emeagwali**.”
At an alumni reunion twenty years later,
in 1990,
an Old Boy of CKC,
the acronym for Christ the King College,
Onitsha, wondered aloud:
“I read about Philip Emeagwali
of CKC
and read about him
in the *Daily Times* newspaper.
I read that Philip Emeagwali
discovered
how to solve the toughest problems
in calculus
and how to solve them
at world record speeds in supercomputing.
I was also in CKC in 1970
and I was in the same class
as Philip Emeagwali.

Yet, I don't remember Philip Emeagwali."
The old boys from the
Christ the King College
of 1970 said to the alumni:
"Oh, don't you remember 'Calculus?'"
In Christ the King College, Onitsha (Nigeria),
they remember me as "Calculus."

41.1.2 Why They Called Me "Calculus"

In Christ the King College,
they called me "Calculus"
because I was the only person
in **Onitsha** (Nigeria)
that was studying calculus
and studying it in June 1970
and at age 15.
My calculus textbook
was written for
research mathematical physicists,
not for a 15-year-old.

I first began learning calculus
from the first few pages
of the 568-paged 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**.
In 1970 and at Christ the King College,
Onitsha (Nigeria),
everybody called me "Calculus."
They called me "Calculus"
because they saw me
solving calculus problems
from **that calculus book.**

41.2.1 Thunder Road to Biafra: We Are Running!

At age 15,
I could not understand
the ordinary differential equation
of calculus
that was in the last chapters
of my 568-paged calculus textbook.
Instead, I was struggling to solve
the problems in chapters one to three
of my calculus textbook of 1970.
That textbook was titled:
"An Introduction
to the Infinitesimal Calculus."
Moreover, at age 15,
I was still in the eighth grade.
At age 15, I was supposed to be
in my final year

at Saint George's Grammar School,
Obinomba, Midwest Region, Nigeria.
Three years earlier, in late April 1967,
there was a reprisal killings
of 50,000 Igbos
who were living outside Igbo Land
but within Nigeria.
In late April 1967, my father, Nnaemeka
James Emeagwali, became afraid that
I might be killed
in Obinomba.
Igbo parents
were withdrawing their children
from Obinomba,
which was midway
between the cities of Benin and Asaba.
From the Vatican, the Pope sent
Monsignor Georges Rocheau
on a fact-finding mission
in both Nigeria and Biafra.
After that fact-finding mission,

Monsignor Georges Rocheau
gave an interview with *Le Monde*,
a newspaper published in Paris (France)
that was dated April 5, 1968.
Monsignor Georges Rocheau
reported in **Le Monde** that:
[And I quote]
"There has been genocide...
the region between the towns
of Benin and Asaba
where only widows and orphans remain,
Federal troops having for unknown
reasons massacred all the men."
[End of quote]
In captured Biafran territories,
every Igbo male over the age of ten
was executed by the Nigerian army.
I was over the age of ten
during the Nigeria Biafra War
and I fled from Nigeria to Biafra
to avoid being executed.

So I was not surprised
when my mother arrived
at my boarding school dormitory
at Saint George's Grammar School,
Obinomba,
and arrived in late April 1967
when I was twelve years old.
My dormitory was named
Erameh's House.
I dropped out of school,
after completing the seventh grade.
I dropped out of school
to return to the safety
of our two-bedroom residence
at the nursing quarter
of the Agbor Central Hospital
in Agbor, Midwest Region, Nigeria.
My father was a nurse
that was employed
at the Agbor Central Hospital.
In early 1967, the nursing quarter

that we lived in
was opposite the Nigerian Prison in
Agbor.
After fleeing from Obinomba,
we felt threatened in Agbor
and my mother and my six siblings
and myself
fled from Agbor
to 4B Egbuna-Adazie Street,
Onitsha (Biafra).
From mid-1966 to early 1967,
fifty thousand Igbos were killed
in street uprisings.
As a result of that uprising and killings,
one million Igbo refugees
sought refuge in Igbo Land.
That crisis was the reason
my family sought refuge
in Onitsha, Igbo Land.
We fled to avoid being killed.
All the Igbo-speaking students
at Saint George's Grammar School,
Obinomba,

also fled to Biafra
to avoid being killed.
Please allow me to quote **Giwa Amu**,
the former Solicitor-General
of the then Midwestern Region
of Nigeria.
In the Nigerian "Sunday Observer"
newspaper
that was dated March 16, 1983,
Giwa Amu said that:

[And I quote]

"For record purposes, however,
let me state fearlessly
that I saw hundreds of unarmed civilians
being shot
at sight in Benin City
when Federal troops
arrived to liberate
the city from rebel [Biafran]soldiers....

There appeared to be a fleeting period
of lunacy
in which Midwesterners
gladly identified their Igbo compatriots
to be shot down
by Federal [Nigerian] troops."
[End of quote]

41.2.2 After the War Was Over

Due to that 30-month long
Nigeria Biafra Civil War
that ended on January 15, 1970,
I was **three years** behind
my 1967 classmates
at Saint George's Grammar School,
Obinomba, Nigeria.
Towards mid-1970,
I felt ashamed to return to Class Two
in Saint George's Grammar School,
Obinomba,

and be placed three years behind
my former classmates
who then were in Class Five
and in their final year
and getting ready to sit for their
West African School Certificate
that was administered
by the West African Examination Council,
called WAEC.
To avoid being shamed
at Saint George's Grammar School,
Obinomba, I re-enrolled
in Christ the King College,
Onitsha, Nigeria,
where all my new class mates in Class Two
were also three years behind.

41.2.3 A Letter From Somewhere in Biafra: The Day of the Long Night

During those three war years,

my family of nine
sought refuge at numerous refugee camps.
My family sought refuge
from the Odoakpu Quarters of Onitsha
to the Enu-Onicha Inland Town section
of Onitsha.
We sought refuge in Enu-Onicha
because Odoakpu Quarters
was getting hit
during the eight-day continuous artillery
bombardment of Onitsha.
The Nigerian Second Division
that was bombing Onitsha
was led by Colonel Murtala Muhammed.
For the eight days inclusive
of October 4 to 12, 1967,
my ancestral hometown of Onitsha
was heavily shelled
from **across** the River Niger
and from the banks of the River Niger
at Asaba (Nigeria).
That eight-day non-stop bombardment
of Onitsha,

was followed by an invasion
launched by a ten-boat armada
of the Nigerian Second Division.
In response to the artillery shelling
of October 4, 1967,
my family fled from our residence
at 4B Egbuna-Adazie Street
in the Odoakpu Quarters of Onitsha (Biafra).
We fled to the birthplace
of my maternal grandfather
at 6C Wilkinson Road
in the Inland Town section
of Onitsha (Biafra).
Unknown to us, fleeing to
6C Wilkinson Road
was like a fish
jumping from the frying pan
into fire.
6C Wilkinson Road
was a shouting distance
from the Biafran military headquarters
in Onitsha.
That headquarters

was at Obi Okosi Primary School,
Onitsha (Biafra).
During the gunfights, of October 12, 1967,
between the Biafran soldiers
and the 15,000 Nigerian soldiers
that were attacking
that Biafran military headquarter,
I saw two Biafran soldiers
hiding in the bushes behind our backyard
and changing from their military uniforms
to civilian uniforms
and fleeing with civilians
and going on AWOL,
the military term for
Absent Without Official Leave.
In that attack by 15,000 Nigerian soldiers
bullets were flying all over
Grandpa Chieka Balonwu's residence
at 6C Wilkinson Road, Onitsha, Biafra.
That flight from Onitsha
was the last time
I saw uncle Stephen Balonwu's impressive
two-storey mansion.

The Balonwu mansion was next-door
at 6A Wilkinson Road, Onitsha, Biafra.
That mansion was bombed
and ground zeroed
by the Nigerian Army.
That invasion of our neighborhood
of Umuasele Village of Onitsha
was led by Colonel Murtala Mohammed,
a future president of Nigeria.
Amidst flying bullets
that killed 10,000 soldiers
on both sides, we fled by foot
from Onitsha (Biafra)
to become refugees
in Nkwelle Ogidi (Biafra).
A few weeks later, we felt threatened
by the advancing Nigerian Army
and we fled from Nkwelle Ogidi (Biafra)
to become refugees
in Awka (Biafra).

41.2.4 The Fall of Awka, Biafra

On January 19, 1968,
the day Awka (Biafra)
was captured by the Second Division
of the Nigerian Army,
we fled a few hours before Awka
was captured
and fled to become refugees
at 14 Mba Road, Onitsha, Biafra.
The famous English spy **Frederick Forsyth**
and author of the bestselling book
"The Dogs of War"
was a journalist in Biafra
and the author of the book
"The Biafra Story."
Frederick Forsyth
toured our refugee camp
in Awka (Biafra)
and toured it
after our camp was captured
by the Nigerian army.

Frederick Forsyth reported
in his book "The Biafra Story:"

[And I quote]
"At Awka, I saw the corpses
of the occupants of a refugee camp....
The men folk
had had their hands tied
before shooting;
to judge from appearances,
the women had been subjected
to appalling mutilations
either before or after death.
The bullet broken bodies
of the children
lay scattered like dolls
in the long grass."
[End of quote]

The fall of Awka (Biafra)
to the Nigerian Army
created a path

that enabled the Nigerian Army
to capture
my ancestral hometown of Onitsha (Biafra).

41.2.5 The Flight to Oba

On Wednesday March 20, 1968
we saw numerous Biafran soldiers
fleeing from nearby Abagana War Front.
Some of those fleeing soldiers
give their relatives a shout out.
That was how we learned that
my ancestral hometown, Onitsha,
would be captured in six hours.
We fled immediately
from 14 Mba Road, Umudei Village, Onitsha
to Merchants of Light School, Oba.
That flight from Onitsha
was the last time
I saw our last residence
that was at 14 Mba Road, Onitsha.

That residence
that was built six-years earlier
was bombed and ground zeroed
by the Nigerian Army.
My cousins **John Okwuosa**
and **Patrick Okwuosa**
were not informed to flee
and they died that night
at their residence at Egerton Street, Onitsha, Biafra.
The **Okwuosa** family residence
at Egerton Street, Onitsha,
was bombed and ground zeroed
by the Nigerian Army.
We fled from Onitsha
and we did so about four hours
before **John Okwuosa**
and **Patrick Okwuosa** could flee.
That four-hour-window
saved the lives of our entire family.
That night
my ancestral hometown of Onitsha
was finally

and permanently captured
by the Nigerian soldiers.
That night
Biafran soldiers of the 11th Division
fled from Onitsha.
That night
the Biafran Army was in total disarray
and lost most of their weapons
as they retreated
from Onitsha to Nnewi.
Please allow me to quote
another eyewitness account
that was titled:
"Nightmare in Biafra."
This account of the night of March 20, 1968
that we fled Onitsha (Biafra)
appeared in the "Sunday Times"
of London [England]
on page 12
of the April 26, 1968 issue:

[And I quote]
"I have seen things in Biafra this week

which no man should have to see.
Sights to search the heart
and sicken the conscience.
I have seen children roasted alive,
young girls torn in two by shrapnel,
pregnant women eviscerated,
and old men blown to fragments.
I have seen these things
and I have seen their cause:
high-flying Russian Ilyushin jets
operated by Federal Nigeria,
dropping their bombs
on civilian centres throughout Biafra ...
[End of quote]

The war correspondent
who wrote the article
"Nightmare in Biafra"
continued:

[And I quote]
"At Onitsha,

under siege from the federal troops,
the three-hundred-strong congregation
of the Apostolic Church
decided to stay on
while others fled
and to pray for deliverance.
Col. [Murtala] Mohammed's Second Division
found them in the church,
dragged them out,
tied their hands behind their backs
and executed them."
[End of quote]

41.2.6 Abagana Ambush

As an aside, ten days later,
the retreating Biafran Army
was able to score a major victory
known as the Abagana Ambush.
On the 31st of March of 1968
in Abagana (Biafra),
a small group of Biafran guerilla soldiers
used their homemade Ogbunigwe rocket

to destroy a Nigerian convoy of 106 cars
that were transporting
6,000 infantry and armor.
Only a few
of those 6,000 Nigerian soldiers
survived the Abagana Ambush.
The Abagana Ambush
is the greatest Biafran battlefield success.
The commander
of those 6,000 Nigerian soldiers
was the future president of Nigeria,
Murtala Muhammad.
A rescue helicopter was used to fly
Murtala Muhammad
out of the Abagana Ambush.
Due to his loss of nearly 6,000 soldiers
at the Abagana Ambush,
Murtala Muhammad
was never allowed to lead men in battle
again.

41.2.7 Merchants of Light Refugee Camp

On the night of Wednesday March 20, 1968
we were the Biafran Igbo refugees
that fled from Onitsha
to Merchants of Light School,
Oba, Biafra.
In our refugee flight
to the Merchants of Light School, Oba,
we followed New Cemetery Road
trekking through Oguta Road,
continuing through
the Queen of the Rosary College.
We trekked twelve and half miles
along the Old Oba Nnewi Road
and we trekked until we arrived at
the Merchants of Light School, Oba, Biafra.
We only spent a night
at the Merchants of Light School,
Oba, Biafra,
before we fled to a refugee camp
in Nnewi, Biafra.
As refugees, we felt threatened

after a night in Nnewi.
We fled from Nnewi to Awka-Etiti.
We camped in a refugee camp
that was near the Awka-Etiti market square
and across the street
from the catholic church.
After about two months in Awka-Etiti,
we were resettled
at the extremely crowded
Saint Joseph's Refugee Camp,
in Awka-Etiti.

41.2.8 Dance of Death Refugees

Most of the refugees
at our new refugee camp in Awka-Etiti
were escapees and survivors
of the Dance of Death
of October 7, 1967.
At the Dance of Death
seven hundred unarmed men
were gunned down

and buried alive
at Ogbe-Eke Market Square, Asaba,
at Ogbe-Osowa, Asaba,
at Saint Joseph's Catholic Church, Asaba,
at Saint Patrick's College, Asaba,
and at Cable Point, Asaba.
Colonel Murtala Mohammed,
the future president of Nigeria,
was the commanding officer
of the Nigerian soldiers that gunned down
those seven hundred unarmed civilian men.
After the Dance of Death killing spree
Asaba was described as a ghost town
and as a town
with women and no men.
Please allow me to quote the "London Observer" issue
of January 21, 1968.

[quote]
"The greatest single massacre
occurred

in the Ibo town of Asaba,
where 700 Ibo males
were lined up and shot."
[unquote]

Back in January 1966,
Major Chukwuma Kaduna Nzeogwu,
who hailed from Okpanam,
a small village at the outskirt of Asaba,
confessed on television
that he killed **Ahmadu Bello**
on January 15, 1966.
Ahmadu Bello
was the revered leader of Northern Nigeria
that was to Northern Nigeria
what **Nelson Mandela**
was to Southern Africa.
So the Asaba Dance of Death killings
of October 7, 1967
of seven hundred unarmed civilian men
was a revenge mass murder
that was executed by the Nigerian Army.
The Dance of Death

was preceded by the retaliatory murder
that occurred on July 29, 1966
of Nigeria's first military president.
That president, Major-General
Johnson Thomas Aguiyi-Ironsi
was killed by Northern Nigerian soldiers.
Major-General Johnson Thomas Aguiyi-Ironsi
was killed in retaliation
for the January 15, 1966
assassination of **Ahmadu Bello**
the leader of Northern Nigeria.

41.2.9 14-Year-Old Reports to the War Front

After about one year, onward of June 1968
at Saint Joseph's Refugee Camp
we made a very dangerous relocation
from Awka-Etiti to Ndoni (Biafra)
with a stopover in Atani (Biafra).
We arrived in Ndoni in about June 1969.
In July 1969, I was conscripted

into the Biafran Army.
I was conscripted
while working as a yam porter
in Ndoni, Biafra.
As a 14-year-old yam porter,
my job was to carry yams
for market women
and carry them from their dug-out canoes
at the bank of the River Niger
to the market at Ndoni riverside.
I was conscripted
at gun point and marched straight
from Ndoni market
to the Biafran side of the Oguta War Front.
I was one of the five hundred new recruits
that were conscripted
to replace
one of the five hundred Biafran soldiers
that were recently killed
in the battle of mid-1969
at the Oguta War Front.
At 3:00 on the morning
of Sunday January 11, 1970,

the Biafran leader, Odumegwu Ojukwu,
flew out from the Uli airstrip of Biafra
and flew to seek asylum
in the west African nation
of Ivory Coast.
But in Odumegwu Ojukwu's
last broadcast speech as the Biafran leader
he euphemistically said that
he was travelling to the Ivory Coast
in [quote unquote] "search for peace."
My family left Ndoni (Biafra)
on about January 17, 1970.
We walked for three days
to arrive in Onitsha.
We spent three months as refugees
at Port Harcourt Road
in the Fegge Quarters of Onitsha.
During those three war years,
onward of April 1967,
I was not enrolled in any school.
I could not enroll in school because
all the schools in Biafra
were closed for **three years**.

Schools near war fronts
were closed and converted to
military training camps
and barracks.
Schools farther from war fronts
were closed and converted into makeshift,
overcrowded housing and **feeding centers**
for Biafran refugees.
My most memorable day in Biafra
was the day in July 1969
I was conscripted into the Biafran army.
I was fourteen years old.
I was briefly sent to the Oguta War Front
of the Nigeria-Biafra Civil War.
Oguta War Front
was one of the bloodiest war fronts
during the Nigerian Civil War.
One in fifteen million Biafrans
died from fighting in war fronts,
and died from hunger and starvation.
Oguta War Front
was one of the few war fronts
that the Biafran Leader,

General Chukwuemeka
Odumegwu Ojukwu, fought in.
Oguta War Front
was where I first heard the name
Colonel Olusegun Obasanjo
and heard that Obasanjo
led an attack
against our Biafran unit
that was defending the town of Oguta.

41.2.10 Use of Calculus in War Fronts

The **ordinary differential equation**
of calculus
is the mathematical technique
that is used to compute
the **flight trajectories**
of the missiles that were fired by
the Nigerian Second Division
that was led by Colonel Murtala Muhammad.
The computer solution

of the ordinary differential equation
of calculus
can be used
to compute the flight trajectory
of the Nigerian missiles
that reached my family residence.
For the eight days
onward of the Fourth of October of 1967,
some of those Nigerian missiles
landed a hundred yards
from my family residence
at 4B Egbuna-Adazie Street, Onitsha
(Biafra).
Colonel Murtala Muhammad
was sending us deadly missiles
from **across** the River Niger
and from the banks of the River Niger
at **Asaba** (Nigeria).
The ordinary differential equation
of calculus
that encodes
the second law of motion
of physics

must be solved with a fast computer.
That numerical solution
can be used to compute *a priori*
the flight trajectories
of the missiles that were fired
by the Nigerian Army
and fired from their gunboats
and fired from the middle of Oguta Lake
to Oguta town.
That need to numerically solve
the ordinary differential equation
of calculus
was the grand challenge problem
of mathematical physics
that inspired the construction
of the first programmable supercomputer.
That sequential processing supercomputer
was constructed back in **1946**,
or nineteen years,
before the **Nigeria-Biafra Civil War**.
That first supercomputer,
that could compute automatically,
was at Aberdeen Proving Ground

of the United States Army,
in Aberdeen, Maryland.
The Aberdeen Proving Ground
was the U.S. Army's facility
for demonstrating how missiles work.
I later developed a relationship
with Aberdeen, in part,
because the city was 26 miles
from my wife's birthplace and hometown
of Baltimore, Maryland.
And, in part, because I declined a job offer
to program vector processing
supercomputers
at Aberdeen Proving Ground.
The first supercomputer
that I sequentially programmed,
back on June 20, **1974**
at 1800 SW Campus Way,
Corvallis, Oregon, United States,
was mostly used
to solve systems of **differential equations**.
Or rather, used to execute
a large set of floating-point

arithmetical operations
that were used to solve
a large-scale system of equations
of algebra
that arose from reformulating
and solving
systems of **differential equations**.

41.3 Chronicles From Unknown Calculus

41.3.1 Calculus to Computing

My scientific journey
was from the frontiers
of the **partial differential equations**
of modern calculus
to the then uncharted territory
of the as-yet-to-be-invented
massively parallel processing
supercomputer.
In that *terra incognita*,

I invented
how to **synchronously communicate**
and how to **simultaneously compute**
and how to do both
across a new internet.
That new internet
is a new global network of
two-raised-to-power sixteen
tightly-coupled processors
that shared nothing with each other.
My contribution
to the development of the modern computer
was the invention
that occurred
on the Fourth of July 1989.
I invented
how those 65,536 tightly-coupled
identical processors
that were already available
in the market
can be married together
as one seamless, cohesive supercomputer.
Those 64 binary thousand processors

were married together
by a new global network of
one binary million regular
and short email wires
that were identical
and that were equal distances **apart**.
In the 1980s,
I was the lone wolf, fulltime programmer
in Los Alamos, New Mexico, United States,
of that massively parallel processing
machinery.
That machinery is the pre-cursor
of the modern supercomputer.
For twenty years, onward of June 1970,
the name "Calculus"
continued to define me.
For instance,
the June 20, 1990 issue
of the *Wall Street Journal*
and various newspapers
reported that I invented
how to compress the **time-to-solution**
of the toughest problems

in modern calculus
and that I invented
how to compress that **time-to-solution**
via the fastest supercomputers
and that I invented
how compress that **time-to-solution**
by a factor of
65,536.
I invented
how to speed supercomputers up
and speed up
across the slowest
65,536
processors
and speed up
to record previously unrecorded speeds
in supercomputing.
The dense, abstract and invisible
partial differential equations
of modern calculus
were the common denominators
within each of the
65,536

tightly-coupled processors
that I used to invent
how to compress the **time-to-solution**
for solving the toughest problems
in calculus.
In 1989, it made the news headlines
that an African Supercomputer Wizard
in the United States
had invented
what was then considered impossible,
namely, how to compress supercomputer
time-to-solution
and compress that time
from 65,536 days, or 180 years,
on one processor
and compress that time
to only one day of **time-to-solution**
and compress that time
across a new internet
that is a small copy
of the Internet.
I am that African Supercomputer Wizard
that was in the news

back in 1989.
I invented that new internet
as a new global network of
65,536
equidistant processors.
I invented that new internet
as a new global network of
as many identical computers
that are equal distances **apart**.

41.3.2 Philip Emeagwali's Contributions to Calculus

Back in June 1970, I used calculus
to study how things change.
Twenty years later,
my contributions to calculus
became the cover story
of the June 1990 issue
of the *SIAM News*.
In the May 1990 issue of the *SIAM News*,
a research computational mathematician
wrote that:

[And I 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*
that profiled my contributions to calculus
is the flagship publication of SIAM.
And SIAM
is the acronym for the Society of Industrial
and Applied Mathematics.
The SIAM is the number one society
for mathematicians.

The *SIAM News*
is where the most newsworthy contribution
to mathematics is first reported.
As reported in the May 1990 issue
of the *SIAM News*,
I invented
36 partial derivative terms
of modern calculus.
Those terms make **excruciatingly-detailed**
petroleum reservoir models
more accurate.
Those models
tell the petroleum engineer
a lot about how crude oil, injected water,
and natural gas
flow from a water injection well
to a crude oil and natural gas
production well.
Calculus
is the common denominator
in my supercomputing research
that was at the **crossroad**
of physics and mathematics and computing.

1942

Calculus
is the most powerful technique
in mathematics.
The **differential equation**
is the most important expression
in **calculus**.
The **partial differential equation**
of **calculus**
is used to foresee global warming
that's, otherwise, unforeseeable.
The partial differential equation
of modern **calculus**
is used to recover crude oil
and natural gas
that are, otherwise, unrecoverable.
The ordinary differential equation
of **calculus**
was used to send men to the moon.
My contribution to **calculus**
is this:
On the Fourth of July 1989
in Los Alamos, New Mexico, United States,
I **invented**

how partial differential equations
that governed
an initial-boundary value problem
of modern **calculus**
can be solved **across** a new internet.
That new internet
is a new global network of
65,536
tightly-coupled processors
that were identical,
that were equal distances apart,
and that shared nothing with each other
and that were already available
in the market anyway.
That new internet
is a new global network of
as many identical computers.
That invention of **how to solve**
initial-boundary value problems
that are governed
by Philip Emeagwali's equations
that is a new system of coupled, non-linear,
time-dependent, and state-of-the-art

partial differential equations
that is the toughest problem in calculus
that are hyperbolic
and **how to solve**
the extreme scale-system of equations
of algebra
that approximates
those **partial differential equations**
and **how to solve** those algebraic equations
across processors
and how to solve them in parallel
was what made the news headlines
back in 1989.
My invention
of the massively parallel processing
supercomputer
made the news headlines because
it was a invention that opened the door
to the modern supercomputer.
That modern supercomputer
is powered by up to ten million
six hundred and forty-nine thousand
six hundred [10,649,600]

1944

processors.
As a large-scale
computational mathematician,
my quest was for the shortest
time-to-solution
for an initial-boundary value problem
that is defined by
partial differential equations
of modern calculus.
In theory,
it takes an infinite **time-to-solution**
to solve
an initial-boundary value problem
and to solve it exactly
and to solve it for real-world problems,
such as general circulation modeling
that must be used to foresee
otherwise unforeseeable global warming.

41.3.3 Contributions to Calculus

The idea of supercomputing in parallel
came to me in 1974.
But in the mid-1970s,
my research in parallel processing
was tongue-in-cheek.
I was young, black, and African.
For that reason, I was not taken seriously.
I did not even take myself seriously, in part,
because the leading minds
in the world of the vector processing
supercomputer,
such as **Seymour Cray**
and the leading minds
in the world of the scalar processing
supercomputer,
such as **Gene Amdahl**
pronounced that it will forever
remain impossible
to invent
the massively parallel processing
supercomputer.
I made the impossible possible
when I experimentally confirmed

a new internet,
that is a new supercomputer,
and that is a new computer.
I invented
the massively parallel processing
supercomputer
and I invented the technology
on the Fourth of July 1989.
But it was not possible, in 1974,
for me to invent
the massively parallel processing
supercomputer
and to invent the technology in 1974.
That invention was impossible
due to the lack of money, the lack of time,
and most importantly,
the lack of the knowledge
of the partial differential equation
of the modern calculus
that is a recurring decimal
in the development
of the fastest supercomputer.
Back in 1974, I also lacked

knowledge of extreme-scaled algebra
that is a recurring decimal
in the development
of the fastest supercomputer.
And I lacked knowledge of
extreme-scaled computational physics
that is a recurring decimal
in the development
of the fastest supercomputer..
The modern supercomputer
that computes in parallel
and solves the toughest problems in calculus
in parallel
is the defining technology
of the Information Age.
The computer of today
that was invented
to solve the partial differential equation
of calculus of today
that, in turn, is used to foresee otherwise
unforeseeable global warming
was the supercomputer of yesterday
that was invented back in 1946.

That supercomputer of 1946
was used to solve
the ordinary differential equation
of calculus of mid-19th century
that, in turn, was used
to calculate the trajectories of missiles.
The computer is integral
to human civilization.
The supercomputer
is the primary engine that powers
the world's economic growth.
The supercomputer is used
to discover and recover otherwise elusive
crude oil and natural gas.
The supercomputer is used
to discover and invent
more fuel efficient cars and faster airplanes
and used to create a greener planet.
The new supercomputer is used
for extreme-scaled
computational fluid dynamics,
such as simulating
unsteady turbulent flows

that is used to design quiet, fuel-efficient,
and green aircrafts.
The invention of a new supercomputer
is akin to creating new wealth.
The invention
of the massively parallel processing
supercomputer—that occurred
on the Fourth of July 1989—
made the sequential processing
supercomputer
that was invented in 1946 obsolete
and made the vector processing
supercomputer
that was invented in the early 1970s
obsolete.
The invention
of the massively parallel processing
supercomputer
changed the content, pedagogy,
and curriculum
of fields related to computer science.
The invention
of the massively parallel processing

supercomputer
gave birth to the fields of
extreme-scale algebra,
high-performance computational
mathematics
and introduced new terminologies
into the modern supercomputer textbook.
Please allow me to take
a retrospective look to 1946, the year
the first sequential processing
supercomputer
was invented
and the year the *New York Times*
first dropped the hint
in its January 11, 1946 issue
that the parallel processing supercomputer
could be invented in the distant future.
The massively parallel processing
supercomputer
that I invented
on the Fourth of July 1989
was as science fiction in 1946
as teleportation is science fiction today.

Teleportation is science fiction
because we cannot teleport ourselves
to the Moon
and do so without **first** traversing
the quarter of a million miles,
or the 238,855 mile distance,
between the Moon and the Earth.
On the early morning of Thursday
June 20, 1974
in Corvallis, Oregon, United States,
I began my quest
for the fastest calculation.
I began that supercomputing quest
on the first supercomputer
to be rated at one million instructions
per second.
I invented
the massively parallel processing
supercomputer
and I experimentally confirmed
that supercomputer
at 8:15 on the morning
of Tuesday the Fourth of July 1989

in Los Alamos, New Mexico, United States.
My invention
made the news headlines because
that new supercomputer
was believed to be fictional.
Prior to my invention of 1989,
the massively parallel processing
supercomputer
was as fictional
as the perpetual motion machine
that violates the first and second laws of
thermodynamics,
namely, that energy cannot be created
or destroyed within an isolated system
and that the entropy
of an isolated system always increases.

I'm **Philip Emeagwali**.

I was in the news because
I invented
a new internet
that is a new supercomputer

and a new computer.
The massively parallel processing
supercomputer
that I invented
was the miracle
that appeared on the Fourth of July 1989
and appeared
in the centers of algebra, calculus,
and physics.
The massively parallel processing
supercomputer
was the miracle
that made the impossible-to-solve
possible-to-solve
and opened the doors to new fields of study.