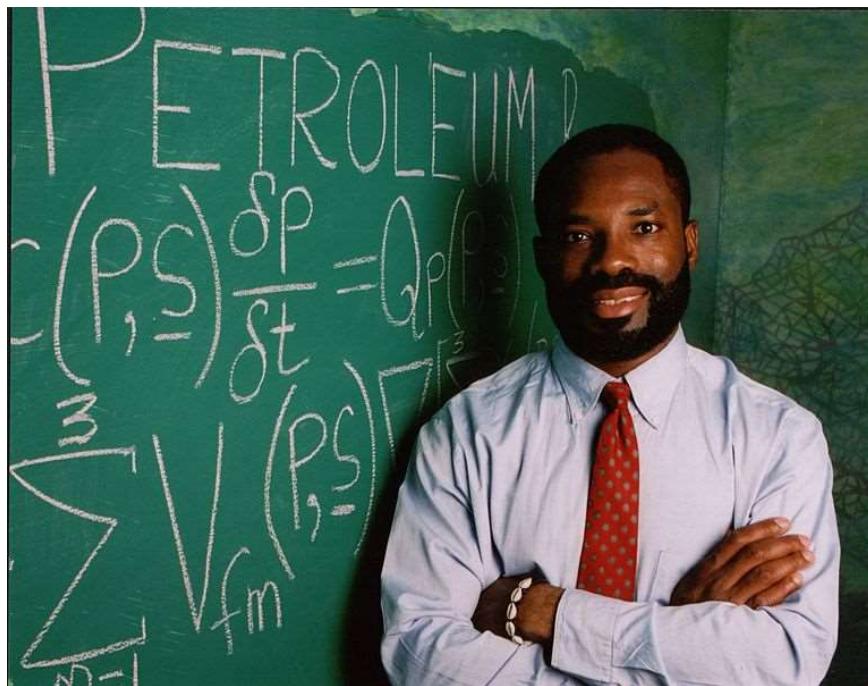


Philip Emeagwali Invention

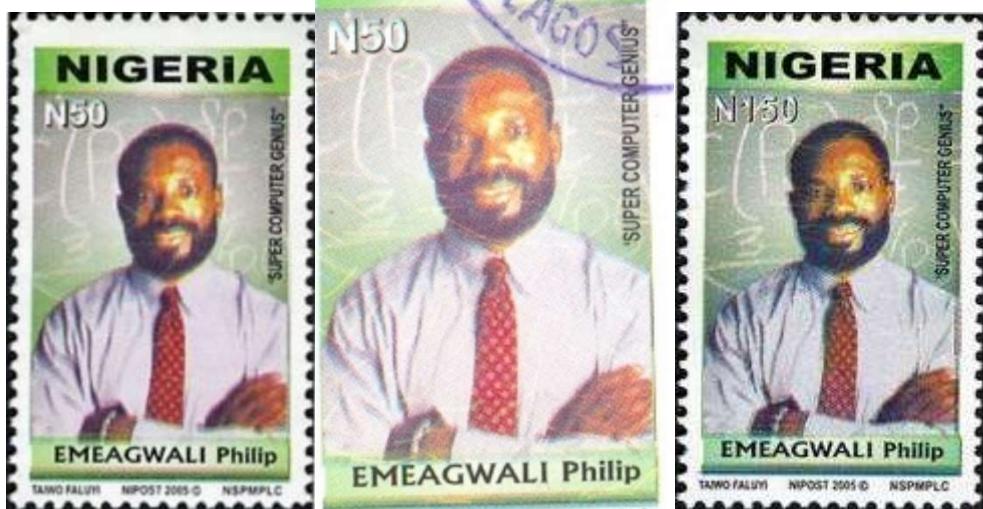
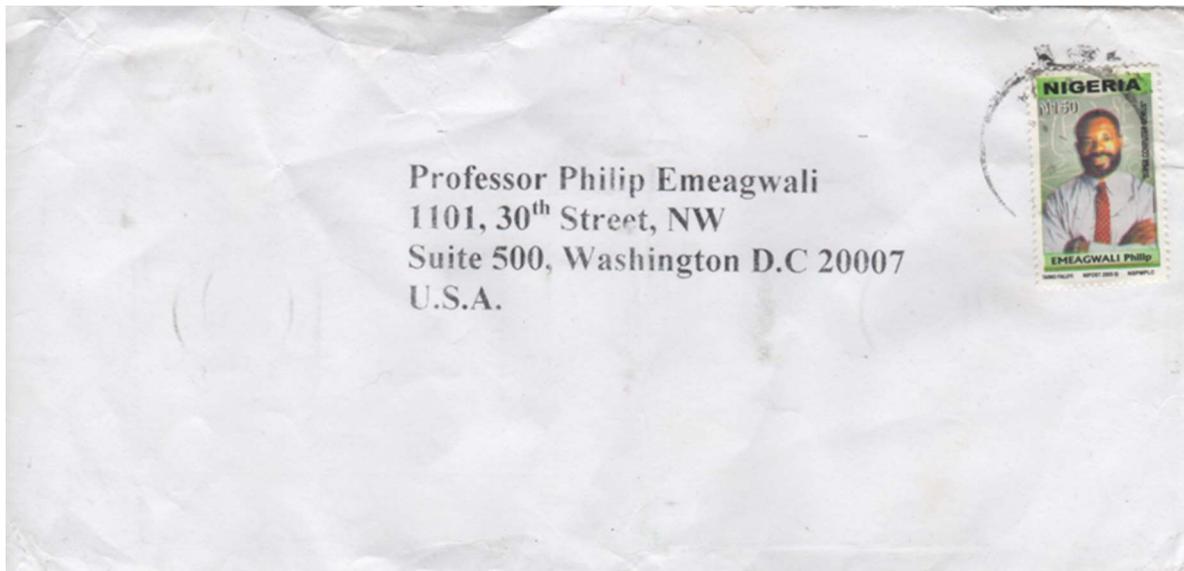
Fastest Supercomputer



Philip Emeagwali discovered how to reduce heavy-duty computations that took one hundred and eighty [180] years, or 65,536 days, within one computer to only one day across 65,536 computers.

Philip Emeagwali discovered

**one hundred and eighty [180] years
in one day....**





CONTRIBUTION to the DEVELOPMENT COMPUTER

x

contribution **of philip emeagwali** to the development **of** computer
the contribution **of gottfried leibniz** to the development **of** computer
contribution **of charles babbage** to the development **of** computer
blaise pascal contribution to the development **of** computer
contribution **of john von neumann** to the development **of** computer
what is the contribution **of john napier** to the development **of** computer
howard aiken- contribution to the development **of** the computer
abacus contribution to the development **of** computer
what did herman hollerith contribution to the development **of** the computer
what was alan turing's contribution to the development **of** computers

Screenshot on February 15, 2013

It is extracted from one billion daily Google searches. It measures global footprints across all seven continents, across history of computing, going all the way to the abacus that was invented five thousand years ago. It is an objective and literal way of measuring the influence of inventors studied in schools for their "contributions to the development of the computer."

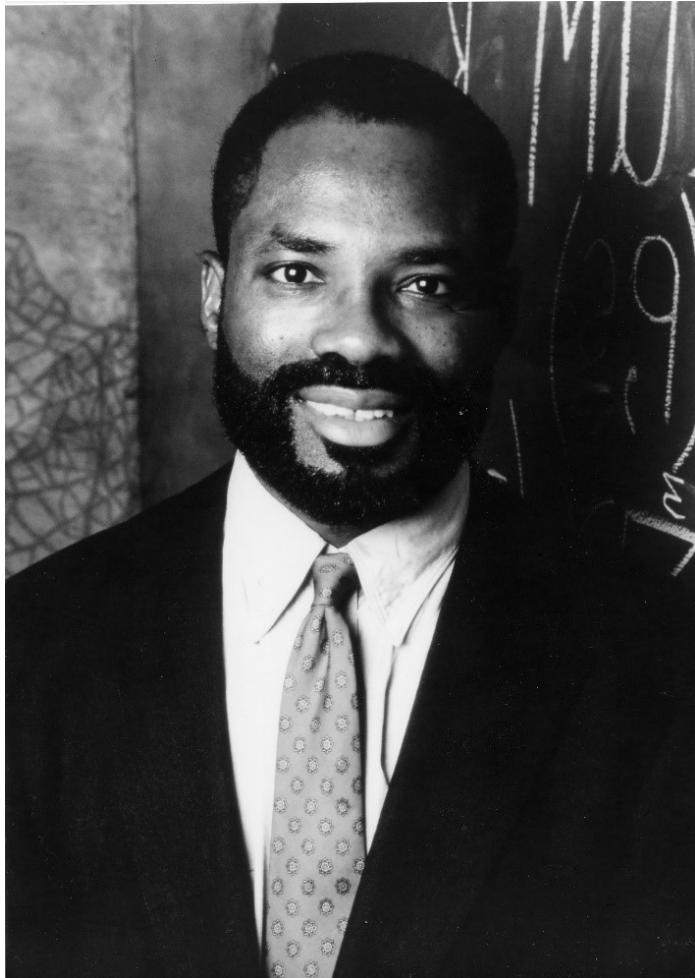




"For contributions to the development of the computer"

TOP 10

FATHERS OF THE COMPUTER



1. **Philip Emeagwali**
2. Gottfried Leibniz
3. Charles Babbage
4. Blaise Pascal
5. John von Neumann
6. John Napier
7. Howard Aiken
8. Abacus
9. Herman Hollerith
10. Alan Turing

PHILIP EMEAGWALI: FAST FACTS

Birth date: August 23, 1954

Birth place: Akure, Nigeria.

Birth name: Chukwurah Emeagwali (pronounced eh-may-ah-gwah-lee)

Father: Nnaemeka James Emeagwali, a 33-year-old hospital nurse in Akure

Mother: Iyanma Agatha Emeagwali, had Philip six days after her 15th birthdate

Marriage: Dale (Brown) Emeagwali (August 15, 1981- present)

Child: with Dale Emeagwali: Ijeoma, June 15, 1990

Research: Attended 500 weekly scientific seminars by the Who's Whos in Science during the decade of the 1980s.

Lectures: Posted at SoundCloud.com/emeagwali and/or YouTube.com/emeagwali

Supercomputer: A global network of 65,536, or two-to-power sixteen, computers visualized on the surface of a globe in the sixteenth dimension.

Primordial Internet: A global network of two-to-power sixteen, or 65,536, computers receiving emails to and from sixteen-bit addresses and along sixteen times two-to-power sixteen, or 1,048,576, bi-directional communication wires, each akin to short telegraph wires.

Most Voted: Number One in school projects on biographies of great computer scientists

Most Searched-For: Contributions to the development of the computer

Philip Emeagwali: Inventions

7

Discovery: How to speed up 180 years of computing to one day of supercomputing.

Invention: Constructively reduced a global network of 65,536 computers—*a.k.a.* an internet—to a supercomputer.

Listed: Top ten's in computing, scientific role models, and sixth Nigerian on Nigerian postage stamps.

Paradigm Shift: From computing within one computer to communicating across 65,536 computers.

Invention Moment! News headlines in 1989 was "African Computer Wizard Wins Top Computing Prize."

Benefit: To foresee unforeseen global warming. To discover oil and gas.

Instrument: Nine in ten supercomputers used for computational physics.

Little Known Fact #1: Philip Emeagwali's lectures are highly reprinted in newspapers.

Little Known Fact #2: Philip Emeagwali controlled more (sixteen) supercomputers than any person that ever lived.

Little Known Fact #3: Philip Emeagwali's discovery amplifies the benefits of the invention of the integrated circuit by a factor of 64 binary thousand.

Little Known Fact #4: In 1989, 25,000 people had supercomputer accounts. And nine in ten supercomputer cycles pertained to physics.

Little Known Fact #5: A supercomputer powered by 65,536 processors only allows one programmer at a time to lock-and-use all 65,536 processors on a 24/7.

Little Known Fact #6: In 1989, only one supercomputer was powered by 65,536 processors. That supercomputer was located at the Los Alamos National Laboratory. It was programmed round-the-clock by Philip Emeagwali.

Little Known Fact #7: The supercomputer powered by 65,536 processors was abandoned, for Philip Emeagwali, because Amdahl's Law described in supercomputer textbooks of the 1980s decreed that it will be impossible to achieve a speedup of up to eight with eight or more processors.

Little Known Fact #8: That abandoned supercomputer that was a global network of 65,536 processors was programmed twenty-four seven (24/7) by only one programmer.

Little Known Fact #9: In 1989, The Computer Society of IEEE issue a press release about the discovery of Philip Emeagwali.

Philip Emeagwali: Inventions

8

Little Known Fact #10: For his discovery of a speed increase of 65,536 fold, Philip Emeagwali became the first computer giant to be extolled in a U.S. presidential speech.



Philip Emeagwali conducted his experiments on the machine shown in the background. He visualized it as a global network of 65,536 computers.

I use the word "internet"
to describe any global network
of computers
as well as their connecting
email wires.

That is, at its core,
an internet ~~is~~ has its base globe
and ~~compr~~ a multitude of computers
and email wires
encircling that globe.

I use my internets
to send and receive emails
between all my computers.

I use my internet
to email numeric data
and to execute arithmetical computations

Philip Emeagwali: Inventions

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that I must solve
to get the fastest answers
to the most computation-intensive problems..
I use use the Laws of physics
codified in prose, algebra, calculus,
algorithms, and codes
that are defined within fluids
that enshroud planet Earth
to get answers to questions
such as: How much oil can be
recovered from an oilfield? Is global
warming a myth or reality.
Global warming can only be computed
by using computers to simulate
the motions of fluids
→ namely, the atmosphere and oceans—
that enshroud the globe.

Philip Emeagwali: Inventions

II

The Internet as you know it
is a network of non-identical
and non-equidistant
computers around ~~a~~ the globe.

You use it primarily
for your slow, asynchronous
communications
between you and your friend
on that globe.

As a mathematician,
the term "globe"
describes an object shaped
like a hypersphere
within a hyperspace.

I named the network of computers
and email wires

Philip Emeagwali: Inventions

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that enshrouds a hypersphere
a hyper internet.

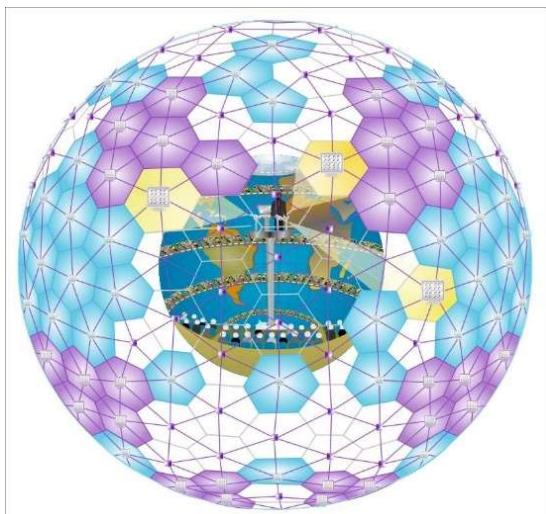
The Internet that enshrouds
planet Earth
grew organically and incrementally.

The Internet that enshrouds
a theorized globe in hyperspace
must be constructed
as a uniform and regular network
of computers and email wires.

It is the uniformity and regularity
that enabled me to program
my hyper internet
to compute simultaneously
and communicate synchronously.

Philip Emeagwali: Inventions

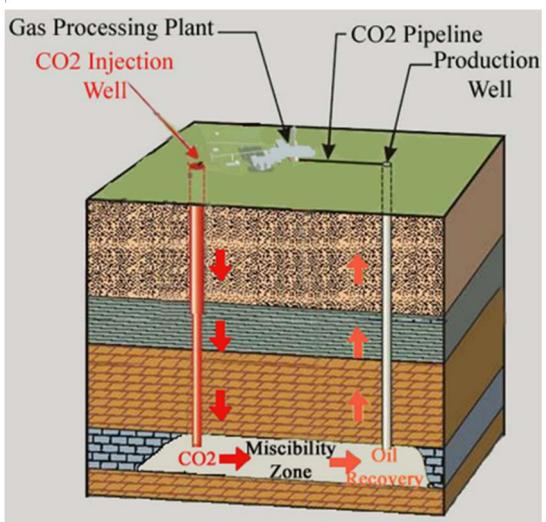
13



Once upon a time, in 1988 to be exact, the fastest computations in physics were executed within one supercomputer.

In 1989, it made the news headlines that Philip Emeagwali theoretically and experimentally discovered that a global network of 65,536 computers can reduce 180 years, or 65,536 days, of computing to just one day of supercomputing.

After his discovery, the fastest supercomputer costs the budget of a small nation and is powered by more than a network of 65,536 computers, called cores and nodes.



Nine in ten supercomputers are used to solve grand challenge problems in computational physics, such as recovering petroleum or foreseeing global warming.

Philip Emeagwali changed the way computers look at physics

On the 50th anniversary of the computer, we salute the brilliant pioneers behind this modern miracle

Just fifty years ago, the world's first electronic computer was unveiled. This remarkable invention has changed our lives faster than any other invention in history. Moreover, the rate of change is accelerating.

The women and men of EDS salute those whose insights, vision and persistence have contributed to developing this remarkable tool.

A leader among them is Dr. Philip Emeagwali. Emeagwali is an interdisciplinary computer scientist and inventor who developed software that allowed multiple processors to tackle complex problems simultaneously, paving the way to solving problems once thought unsolvable.

Inspired by the complex designs of nature, Emeagwali used geometry to prove that bees use the most efficient method possible to construct their honeycombs. He reasoned that a computer

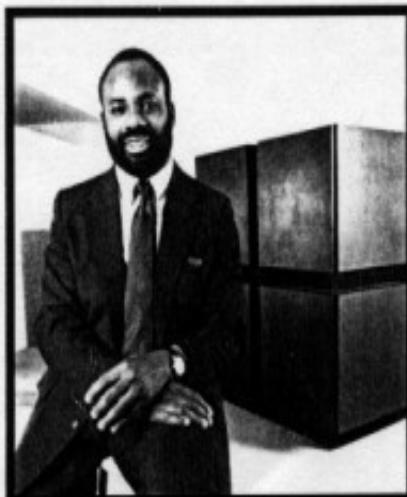
based on the honeycomb design could improve efficiency. It did. His design breakthrough allowed 65,000 processors working together to perform the world's fastest computation at 3.1 billion calculations per second.

That was three times the speed of the fastest supercomputers of the day – at one-fifth the cost.

Today, he is pushing the limits of computing and networking even further. Dr. Emeagwali's inventions have helped improve yields from oil reservoirs as well as the accuracy of weather forecasting.

He is also working on developing supercomputers powerful enough to simulate weather trends over a century to investigate atmospheric warming.

EDS applauds Dr. Emeagwali and all those who are harnessing the power of information to improve life for millions. Without their work, we couldn't do ours.



Dr. Philip Emeagwali

Philip Emeagwali: Inventions

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That lone programmer was Philip Emeagwali.

Philip Emeagwali: Inventions

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I'm Not a Human Being

all 65,536
computers

~~Because I~~ programmed → alone, And I
alone

named my techniques and
for harnessing them as one seamless
technologies by my own

convention. One of my cardinal rules

for naming
cardinal rules is that the my

technology defines the name,

not the name define the my

technology. That is why I

defined my ~~network~~ sixteen-network-

deep network of two-to-the-power

sixteen computers as an internet
metaphorically

that is shaped like a cube in

the sixteenth dimension that

F-a-m-o-u-s-a-h-u-m-a-n-B-e-i-n-g-O-1

Philip Emeagwali: Inventions

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sent sends and receiving emails to sixteen-bit email addresses, each via sixteen times two-to-power

sixteen communication wires that enabled it to compute and to communicate two-to-power

sixteen times faster than your computer.

or two-to-power sixteen,

computer 65,536 times faster
When I succeeded, I cried:

"I'm not a human being!" I'm

a primordial cyborg with a

three pound, three dimension

brain powered by 86 billion neurons

and enhanced by a weightless
I-am-not-a-human-being-02

Philip Emeagwali: Inventions

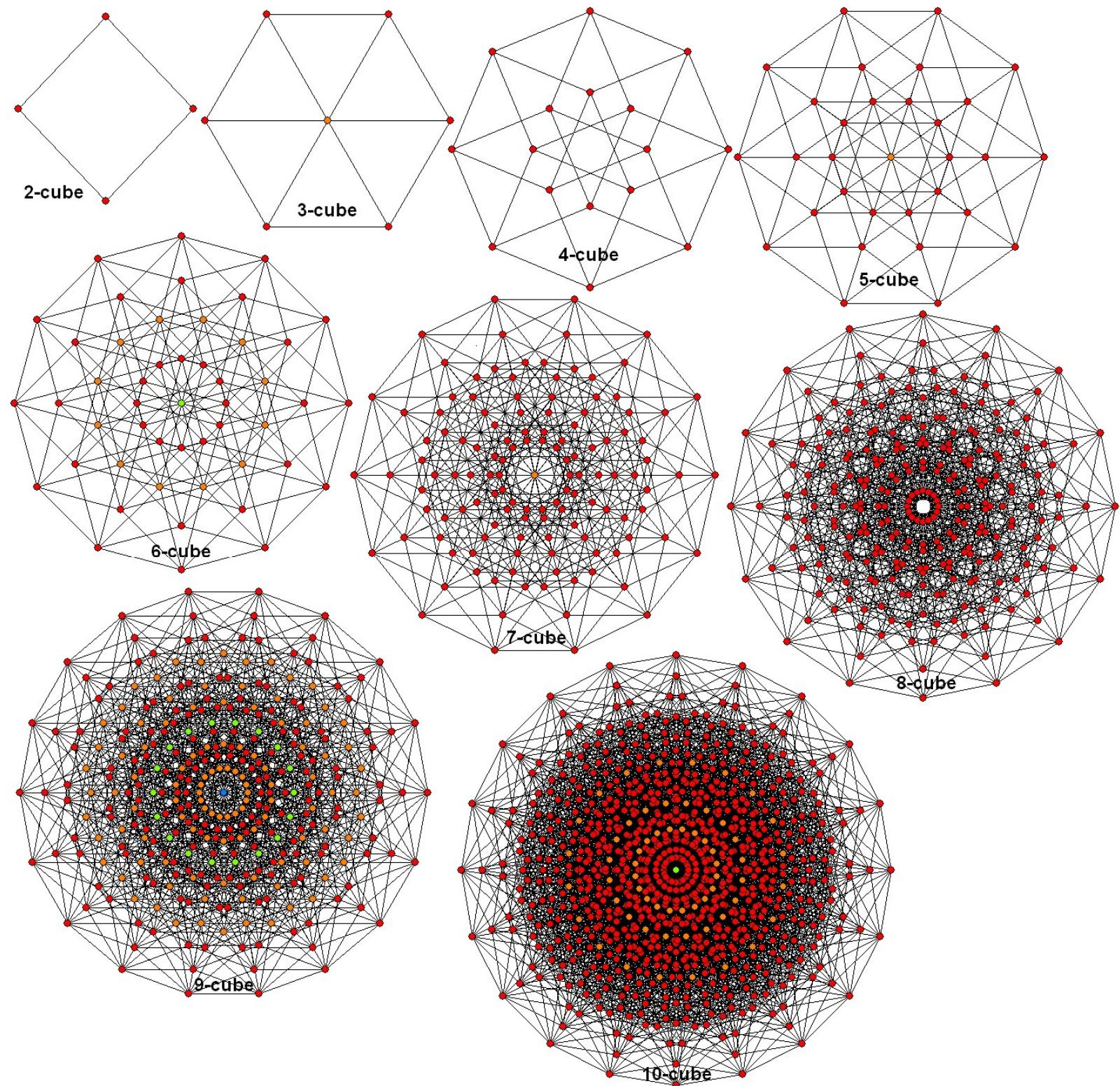
18

I envisioned my internet as stripped naked, nearly naked, to its steel skeleton. It only had a "bikini," which was my metaphor for it, or 65,536 computers, and a "bra" or 1,048,576 short wires. electronic brain powered by 65,536 computers.

I programmed by own rules. That is, I insisted that my network of 65,536 computers define the name internet and not the name define the technology. At its core, my technology is both a supercomputer and a super internet. It was beyond super because and a super internet. because it was a network of 65,536 computers that emailed each other via their 1,048,576 communication wires, that were short channels. I-am-not-a-human-being_03

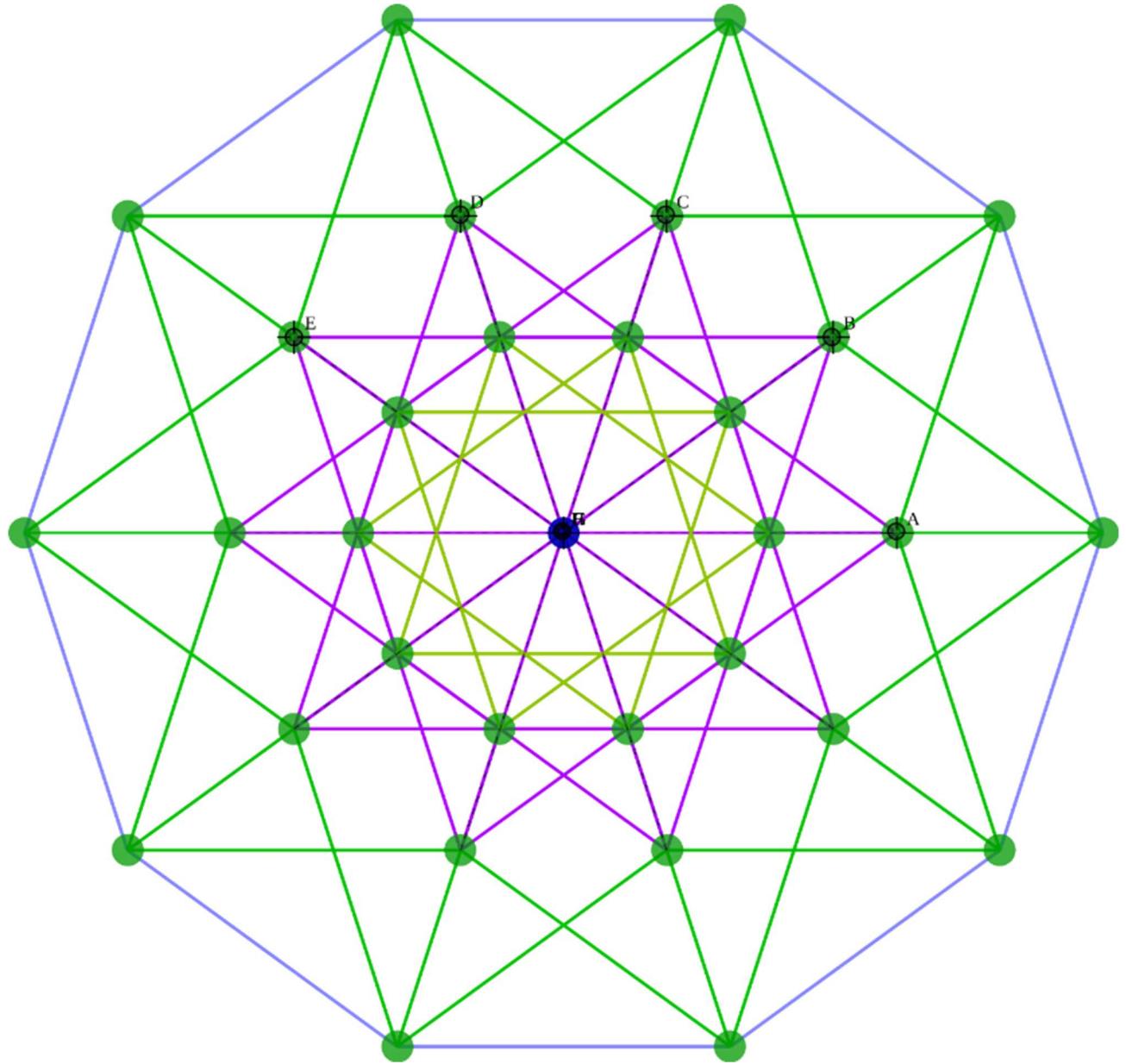
Philip Emeagwali: Inventions

19



Philip Emeagwali: Inventions

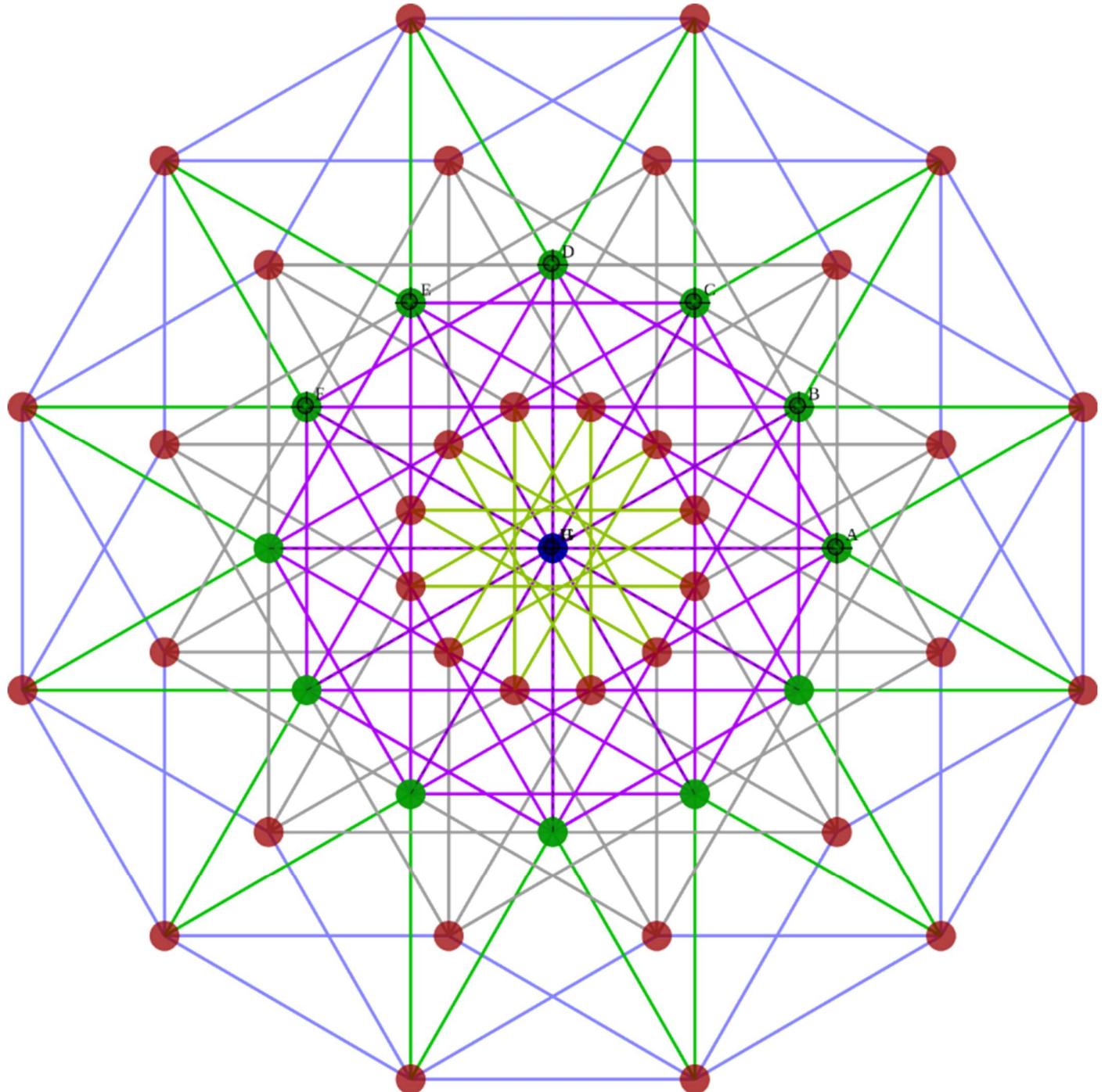
20



The lines and red dots represent the email paths and 32 computers within a global network of two-to-power five computers, as visualized, theorized, and experimentally programmed by Philip Emeagwali.

Philip Emeagwali: Inventions

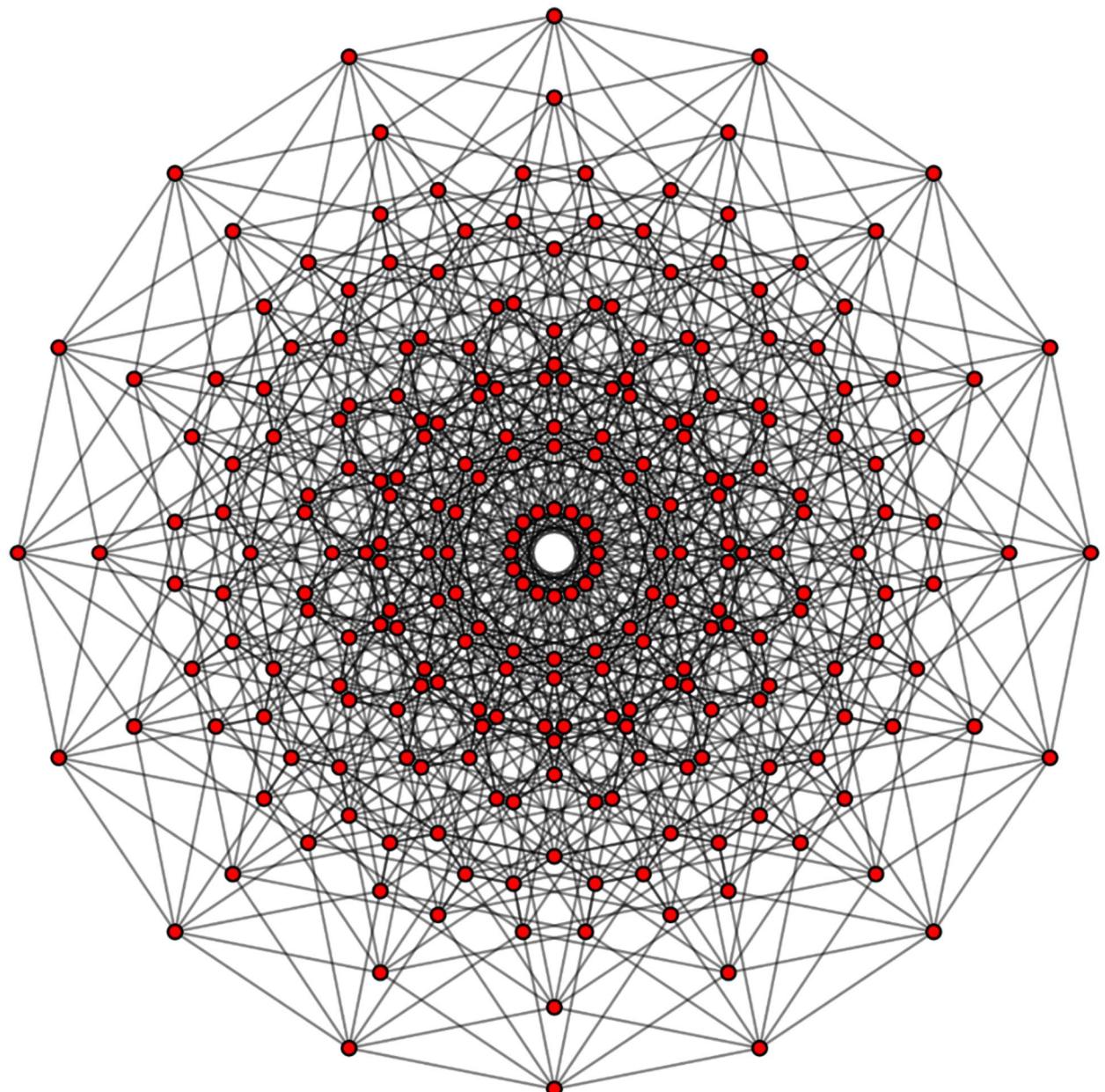
21



The lines and red dots represent the email paths and 64 computers within a global network of two-to-power six computers, as visualized, theorized, and experimentally programmed by Philip Emeagwali.

Philip Emeagwali: Inventions

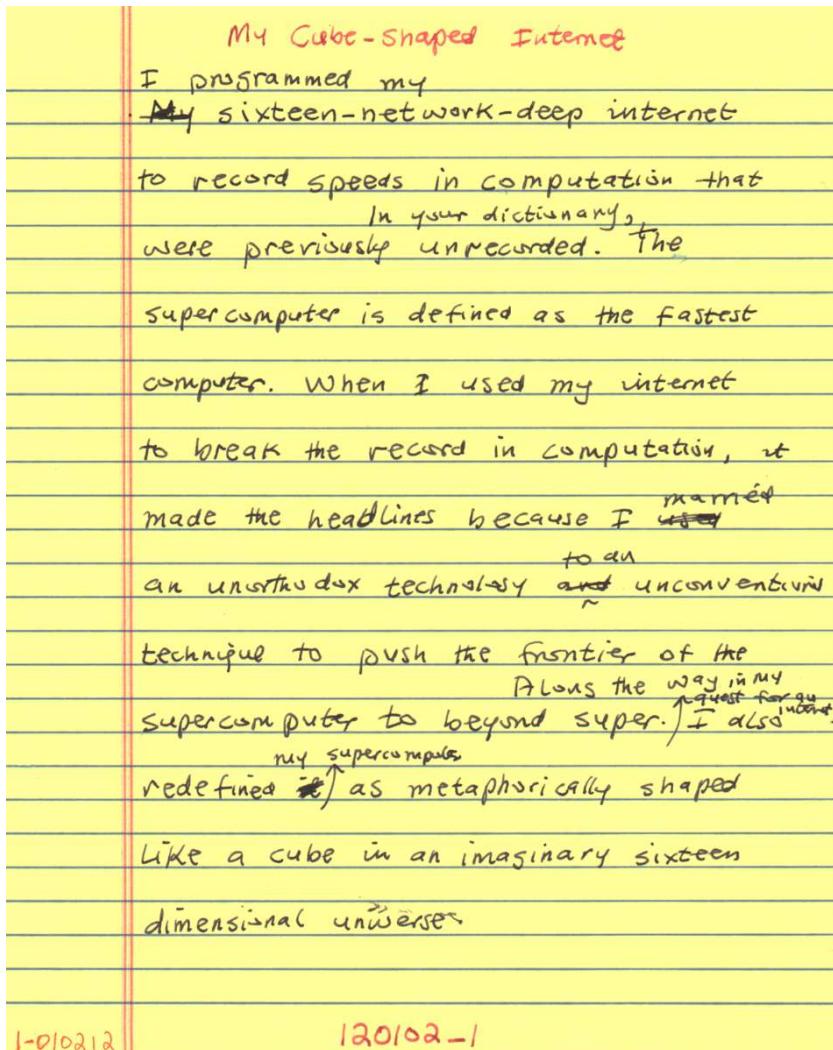
22



Philip Emeagwali: Inventions

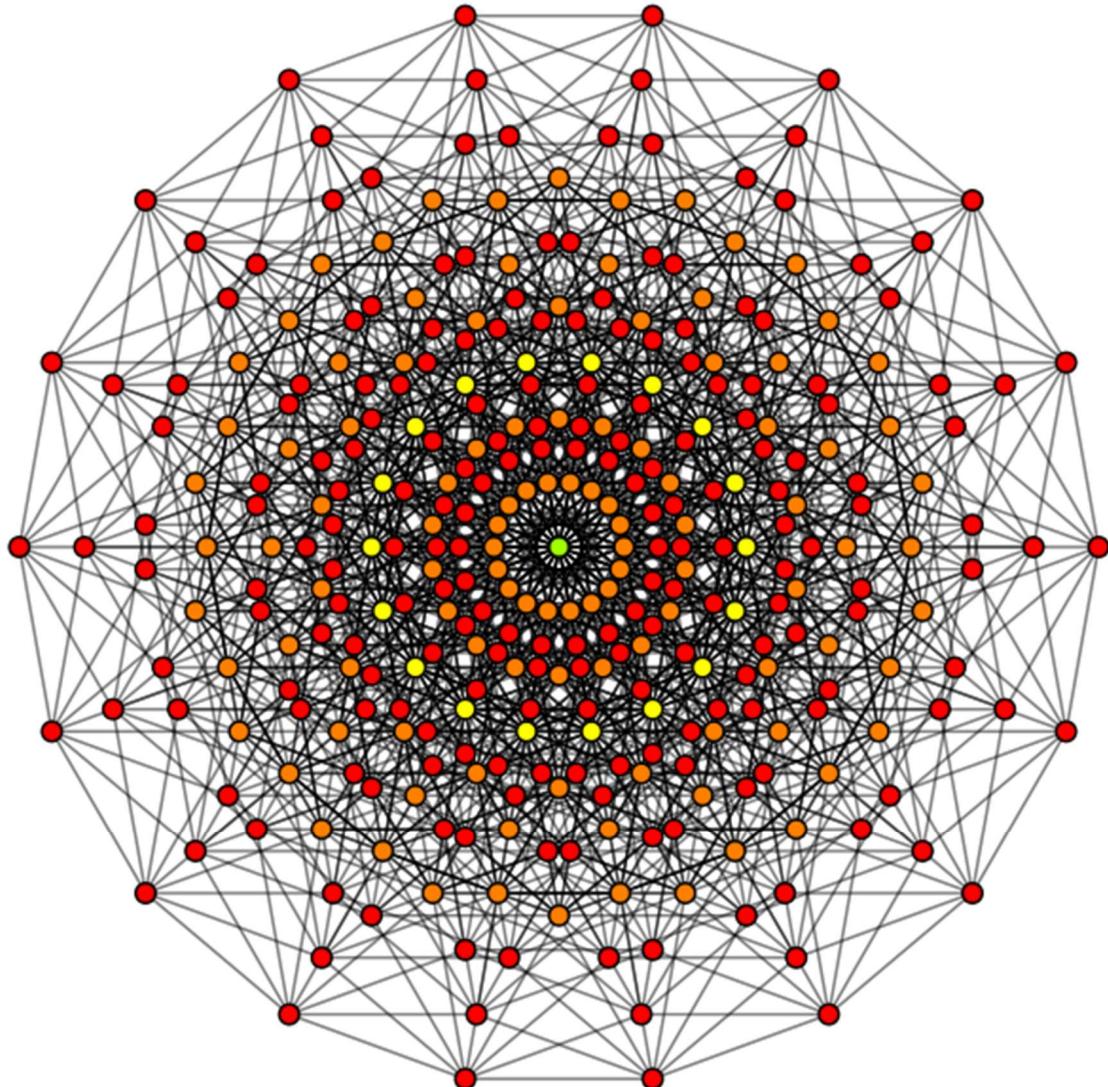
23

The lines and red dots represent the email paths and 256 computers within a global network of two-to-power eight computers, as visualized, theorized, and experimentally programmed by Philip Emeagwali.



Philip Emeagwali: Inventions

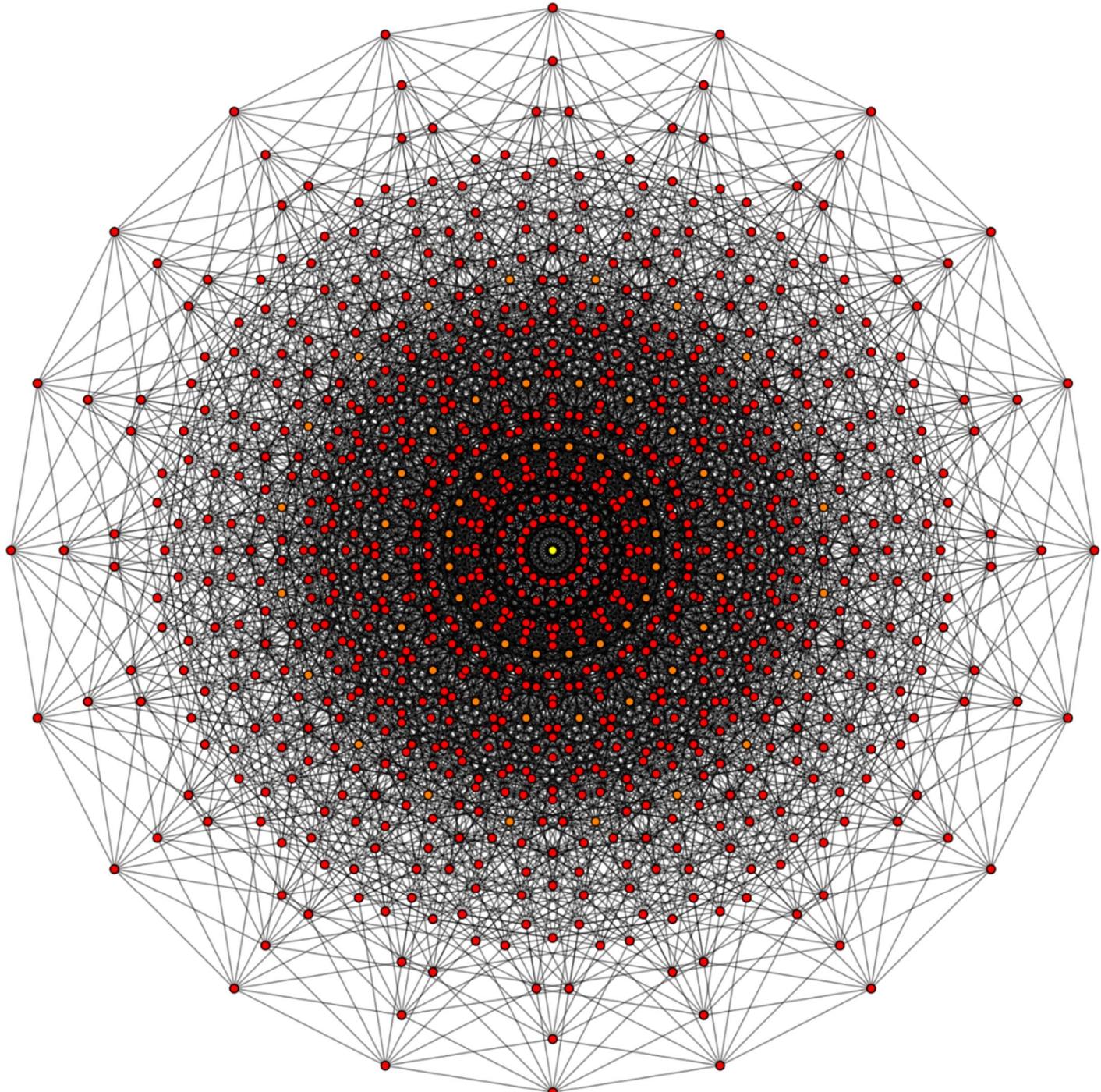
24



The lines and red dots represent the email paths and 512 computers within a global network of two-to-power nine computers, as visualized, theorized, and experimentally programmed by Philip Emeagwali.

Philip Emeagwali: Inventions

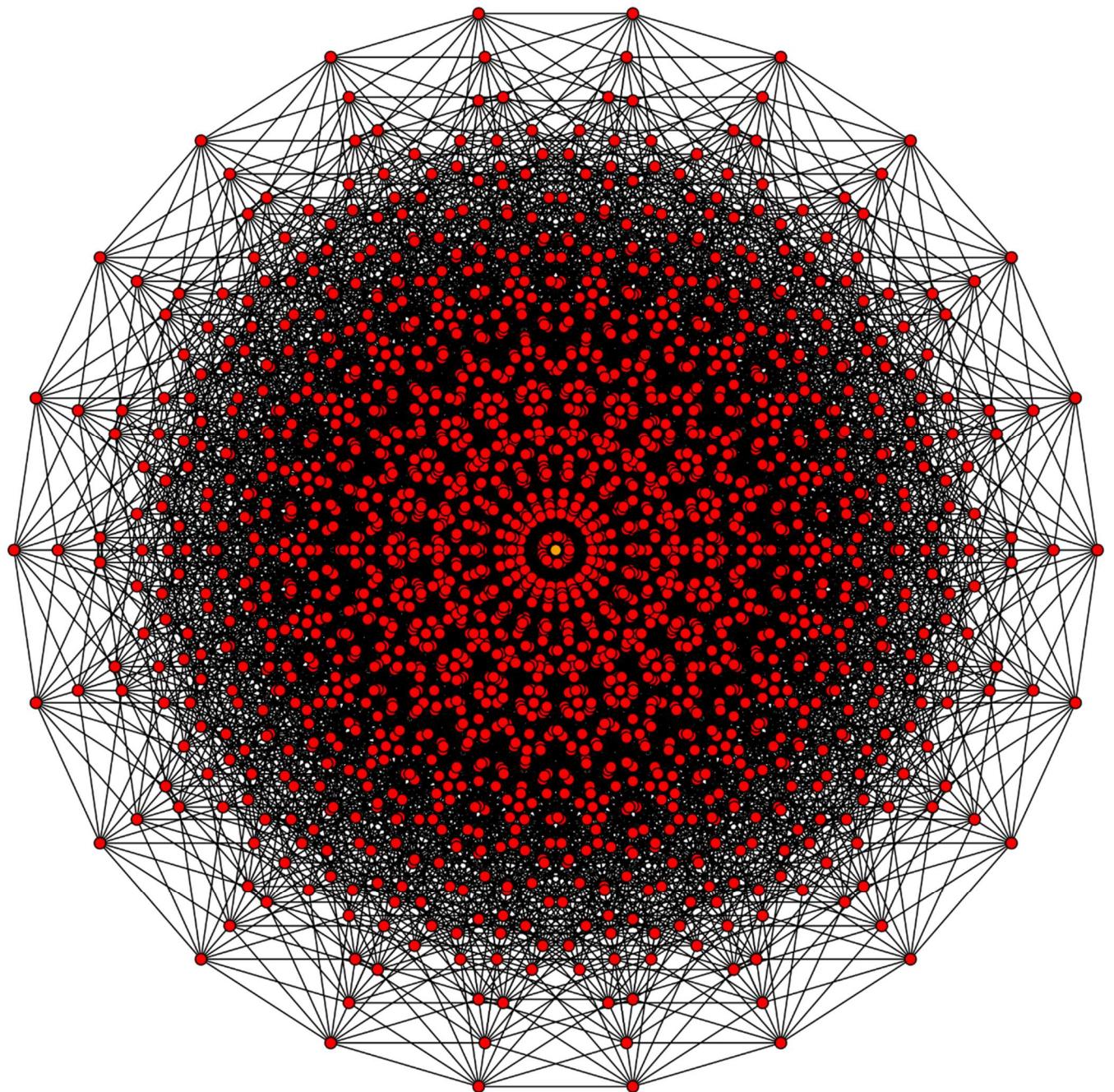
25



The lines and red dots represent the email paths and 1,024 computers within a global network of two-to-power ten computers, as visualized, theorized, and experimentally programmed by Philip Emeagwali.

Philip Emeagwali: Inventions

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The lines and red dots represent the email paths and 2,048 computers within a global network of two-to-power eleven computers, as visualized, theorized, and experimentally programmed by Philip Emeagwali.

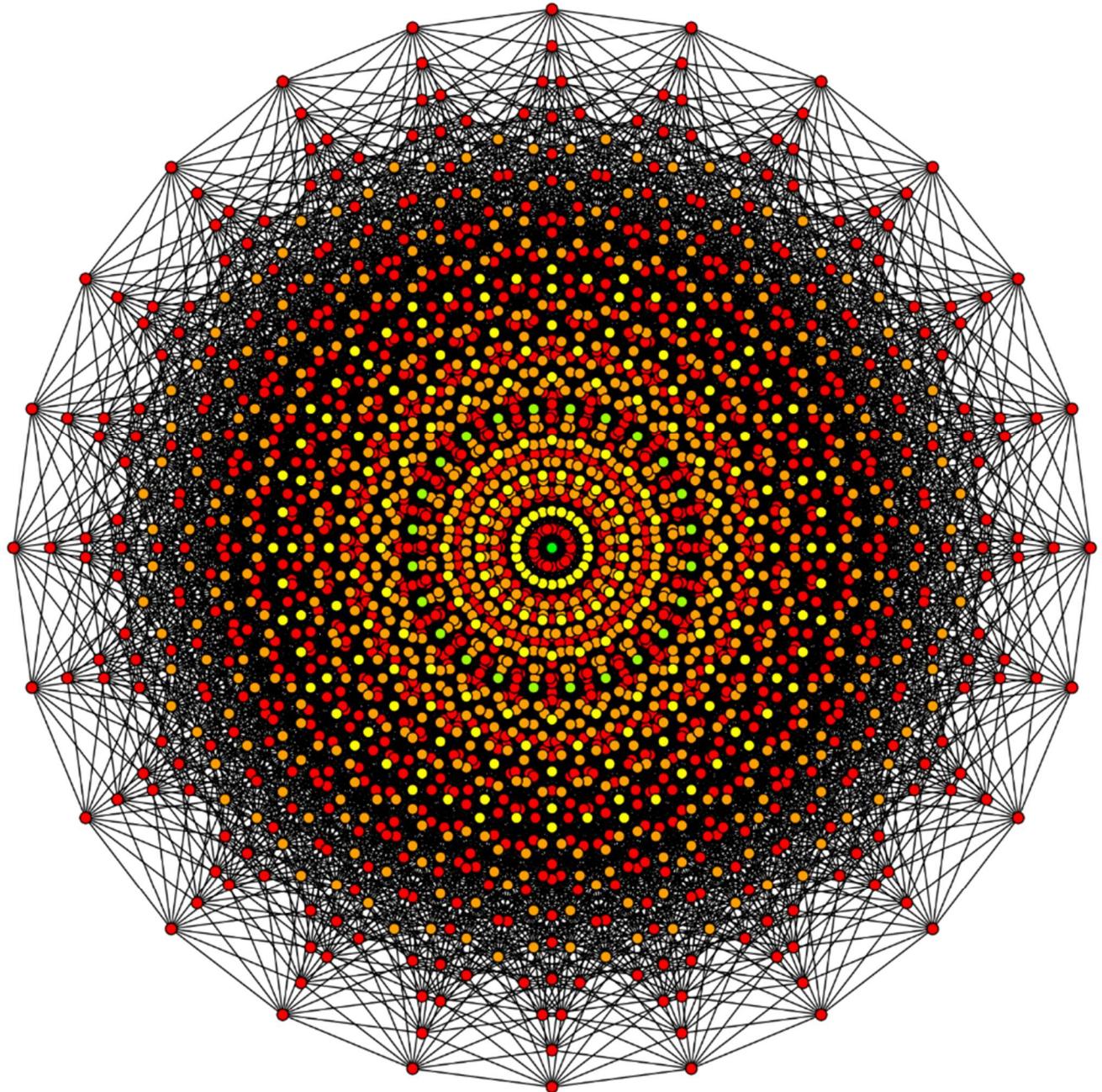
Philip Emeagwali: Inventions

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The geometric positions of the computers did not affect the total speed of the computational physics. The topological positions affect the speed of the computational physics. For global circulation modeling for global warming, the grand challenge initial-boundary value problem can be visualized as a planet-sized global network of 65,536 computers positioned on the two-dimensional ground of a soccer stadium.

Philip Emeagwali: Inventions

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The lines and red dots represent the email paths and 4,096 computers within a global network of two-to-power twelve computers, as visualized, theorized, and experimentally programmed by Philip Emeagwali.

Philip Emeagwali: Inventions

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Twelve dimensional email pathways with 4096, or two-to-power twelve, computers that were visualized as equal distances apart on the eleven-dimensional hypersurface of a hyper-globe in twelve-dimensional hyperspace.

The collage includes:
- A large portrait of Philip Emeagwali on the right.
- A quote in white double quotes: "...being a refugee during the Biafran war made me street smart. It equipped me with a greater sense of determination and vision."
- A small inset photo of him standing in front of server racks.
- A map of Nigeria with a red dot indicating its location.
- Text on the left: "Philip was among millions of refugees who fled persecution during the Biafran war of 1967 in Nigeria that left one million people dead. He was conscripted into the Biafran army at age 14 and migrated to USA at age 19."
- Text at the bottom left: "In 1989 against the backdrop of racial discrimination in the US, Philip proved skeptics wrong by programming all 65,536processors in a supercomputer to perform the world's fastest computation of 3.1 billion calculations per second."
- Logos for the University of Cambridge and the Center of African Studies, University of Cambridge.
- A small caption at the bottom right: "Pictures courtesy of ©emeagwali.com".

Philip Emeagwali: Inventions

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The BBC television hailed Philip Emeagwali as a “digital giant.”

http://news.bbc.co.uk/2/hi/in_depth/sci_tech/digital_giants/8561413.stm

Philip Emeagwali: Inventions

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Dale and Philip Emeagwali
(Silver Spring, Maryland. Circa December 1983)

The Philadelphia Inquirer

Friday, February 26, 1999

He's an intellectual inspiration

Philip Emeagwali spurns the title of genius. Nurturing is the key, he told Willingboro parents.

By David Cho

INQUIRER SUBURBAN STAFF

WILLINGBORO — Philip Emeagwali, a man of immeasurably high intelligence, spurns the description people most often attach to him: genius.

"I don't like that term. People think it only means genius in the mathematical sense or that it refers to a select group of people," Emeagwali, 44, told about 50 parents last night at a public forum on schools. "But I think every one of us has the power to be a genius. I was not born a genius; it was nurtured in me by my father."

When he was 10, growing up in western Nigeria, Emeagwali was drilled daily by his father to solve 100 math problems in one hour. There was no time to write solutions on paper — he had 36 seconds per problem. So Emeagwali did them in his head.

"People later called me a mathematical genius, but you would be a genius, too, if you had to do 100 math problems in an hour," he said.

In the last two days, the man who has been called "one of the greatest intellectual giants Africa has produced" has been taking his message — the importance of homework, cultivating encouragement at home, and surmounting obstacles — to a school district that has been mired in problems.

Standardized test scores here sank

to such lows in recent years that the state placed the district in a special monitoring program. And even as the roofs of the town's school buildings crumbled, taxes soared.

Not that Emeagwali didn't have his own trials to overcome.

When he was 12, Emeagwali lived underneath ceilings that crumbled from rocket shells. From 1967 to 1970, Nigeria fell into civil war, forcing schools to close. Emeagwali had finished only seventh grade.

"We ate only once a day. Some days we had nothing to eat. We were among the poorest families in the world," Emeagwali told students at a high school assembly earlier in the day. "Growing up poor and overcoming several obstacles made me a stronger person. I became more determined to succeed in life."

Studying on his own from 6 a.m. to midnight, Emeagwali passed entrance examinations to the University of London with top grades. In 1974, he immigrated to the United States, obtaining degrees in several subjects. His parents and eight younger brothers and sisters followed him to America.

Since then, Emeagwali, whose IQ is too high to be measured on conventional tests, has put together a resume that extends like the decimals of pi. He is listed in Who's Who in the World and Who's Who in America. He has won numerous awards, including the Gordon Bell

Prize — computer science's Nobel Prize. He devised ways of making oil fields more productive, saving the United States hundreds of millions of dollars a year. His inventions include the world's fastest computer, which in 1989 computed 3.1 billion calculations in one second.

He is now setting up a consulting firm in Baltimore, whose services are wanted by everybody from the United Nations to telecommunications firms.

While this was only his third speaking engagement in schools, students in Willingboro gave an enthusiastic response to his message, mobbing him with questions and requests for autographs after his speech. He is scheduled to speak at Willingboro's Bookbinder and Pencypacker Park Elementary Schools today.

Emeagwali came to Willingboro after Robert Matthews Jr., a sixth grader at Garfield East Elementary School, asked him, via e-mail, to speak at his school. Matthews had been assigned to do a report on an African American scientist for Black History Month.

School administrators then asked Emeagwali to speak to parents at a public forum, which was scheduled for last night. Draped in a sky-blue North African robe and cap, Emeagwali stood out in an otherwise formally suited crowd.

"Genius is not beyond the reach of these students," he told the parents. "You just need to show them how to tap into the genius that lies within them."

Philip Emeagwali: Inventions

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One of Our Great Minds of the Information Age

BY PRESIDENT BILL CLINTON



<https://www.youtube.com/watch?v=Z0uzicpb1Is>

**“One of the great minds
of the Information Age
is a Nigerian American
named Philip Emeagwali.**

**He had to leave school
because his parents
couldn't pay the fees.**

**He lived in a refugee camp
during your civil war.**

**He won a scholarship
to university and went on
to invent a formula
that lets computers make
3.1 billion calculations
per second. (Applause.)**

**Some people call him
the Bill Gates of Africa.**

(*Laughter and applause.*)

**But what I want to say
to you is there is
another Philip Emeagwali
-- or hundreds of them --
or thousands of them
-- growing up in Nigeria today.**

**I thought about it
when I was driving in**

**from the airport and
then driving around
to my appointments,
looking into the face
of children.**

**You never know
what potential
is in their mind and
in their heart;
what imagination they have;
what they have already
thought of and**

**dreamed of
that may be locked in
because they don't have
the means to take it out.**

That's really what education is.

It's our responsibility

to make sure

all your children

have the chance

to live their dreams

so that

you don't miss

**the benefit
of their contributions and
neither does the rest of the world."**



Philip and Dale Emeagwali, March 2001

Philip Emeagwali: Inventions

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Philip Emeagwali: Inventions

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TIME

Reprinted from the archives of TIME magazine:

<http://web.archive.org/web/20110311160315/http://www.time.com/time/2007/blackhistmth/bios/04.html>

TIME

PHILIP EMEAGWALI: A Calculating Move

Friday, Jan. 12, 2007

PHILIP EMEAGWALI, A CALCULATING MOVE

By Madison Gray

http://content.time.com/time/specials/packages/article/0,28804,1963424_1963480_1963457,00.html

It's hard to say who invented the Internet. There were many mathematicians and scientists who contributed to its development; computers were sending signals to each other as early as the 1950s. But the Web owes much of its existence to Philip Emeagwali, a math whiz who came up with the formula for allowing a large number of computers to communicate at once.

Emeagwali was born to a poor family in Akure, Nigeria, in 1954. Despite his brain for math, he had to drop out of school because his family, who had become war refugees, could no longer afford to send him. As a young man, he earned a general education certificate from the University of London and later degrees from George Washington University and the University of Maryland, as well as a doctoral fellowship from the University of Michigan.

Philip Emeagwali: Inventions

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At Michigan, he participated in the scientific community's debate on how to simulate the detection of oil reservoirs using a supercomputer. Growing an oil-rich nation and understanding how oil drilled, Emeagwali decided to use this problem as the subject of his doctoral dissertation. Borrowing an idea from a science fiction story about predicting the weather, Emeagwali decided that rather than using 8 expensive supercomputers he would employ thousands of microprocessors to do the computation.

The only step left was to find 8 machines to connect them. (Remember, it was the 80s.) Through research, he found a machine called the Connection Machine at the Los Alamos

National Laboratory, which had sat unused after scientists had given up on figuring out how to make it simulate nuclear explosions. The machine was designed to run 65,536 interconnected microprocessors. In 1987, he applied for and was given permission to use the machine, and remotely from his Ann Arbor, Michigan, location he set the parameters and ran his program. In addition to correctly computing the amount of oil in the simulated reservoir, the machine was able to perform 3.1 billion calculations per second.

The crux of the discovery was that Emeagwali had programmed each of the microprocessors to talk to six neighboring microprocessors at the same time.

The success of this record-breaking experiment meant that there was now a practical and inexpensive way to use machines like this to speak to each other all over the world. Within a few years, the oil industry had seized upon this idea, then called the Hyperball International Network creating a virtual world wide web of ultrafast digital communication.

The discovery earned him the Institute of Electronics and Electrical Engineers' Gordon Bell Prize in 1989, considered the Nobel Prize of computing, and he was later hailed as one of the fathers of the Internet. Since then, he has won more than 100 prizes for his work and Apple computer has used his microprocessor technology in their Power Mac G4 model. Today he lives in Washington with his wife and son.



Philip Emeagwali: Inventions

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"The Internet as we know it today did not cross my mind," Emeagwali told TIME. "I was hypothesizing a planetary-sized supercomputer and, broadly speaking, my focus was on how the present creates the future and how our image of the future inspires the present."



Philip Emeagwali: Inventions

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Dale, Ijeoma and Philip Emeagwali (MIT, Cambridge, MA, June 8, 2012). Ijeoma works at Google.

“True innovators understand that **the technique of the calculus is not isolated from the technology of the computer**, which is a tool for solving problems in physics. The innovator's knowledge of all three subjects is part of a connected whole.” Philip Emeagwali [April 26, 2010, Geneva, Switzerland]

Philip Emeagwali: Inventions

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NATURE'S OWN NUMBERS MAN



Published 27 January 1997

Upstream is the weekly, international oil and gas newspaper that covers the most important technological developments.

Upstream is published in Oslo, Norway.

The three-part review of the contributions of Philip Emeagwali to the discovery and recovery of oil and gas is reproduced below.

"The unorthodox innovator has pushed back the boundaries of oilfield science"—*Upstream*

Philip Emeagwali: Inventions

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Page 22

UPSTREAM PROFILE

27 January 1997

The awards keep flowing for computer wizard Dr Philip Emeagwali. The unorthodox innovator has pushed back the boundaries of oilfield science but life in America is tainted by 'pervasive racism'

BARRY MORGAN
from Accra

NIGERIAN-born Dr Philip Emeagwali has an enviable reputation in the oil industry for his achievements in computing, gathering a hatful of awards from around the world.

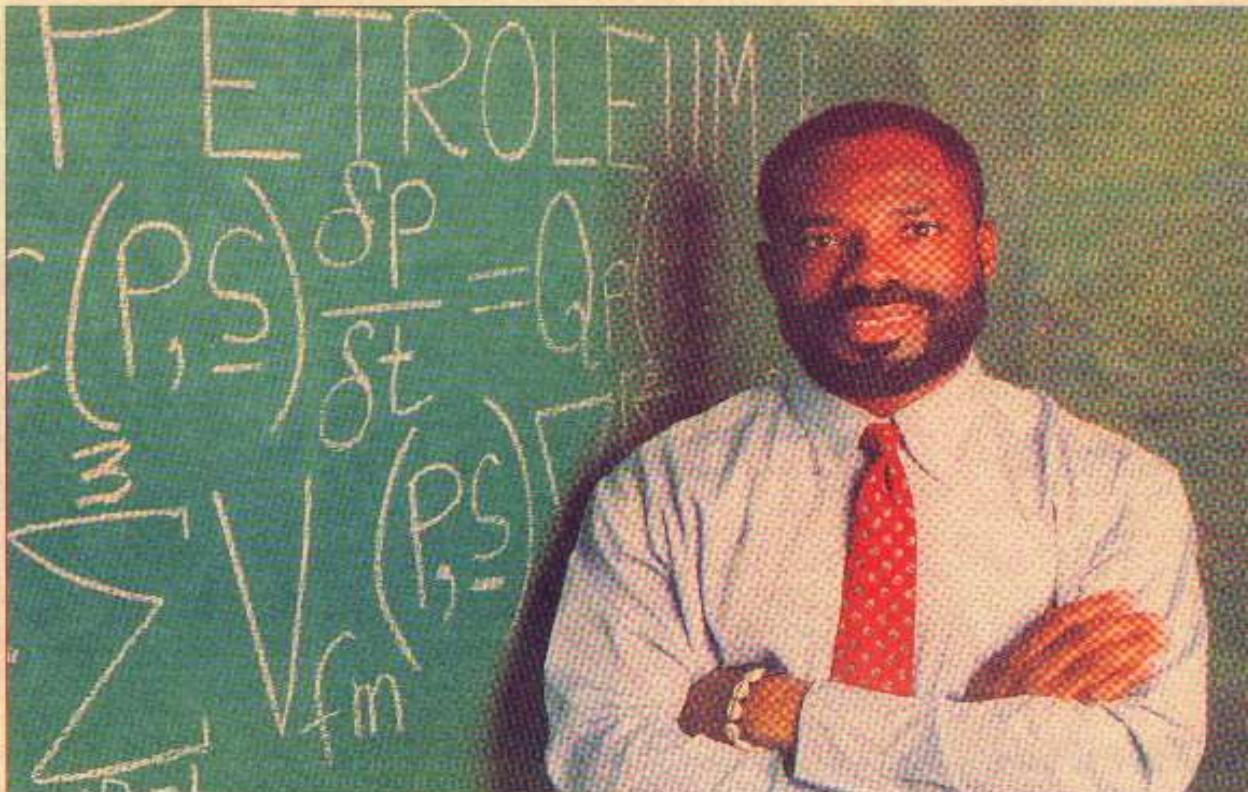
He first shot to fame in 1989 when he won the coveted Gordon Bell Prize for his work with massively parallel computers. He programmed a Cray Connection Machine to compute a world record 3.1 billion calculations per second using 65,536 processors to simulate oil reservoirs.

He has been busy recently on work that could lead to a better understanding of reservoir mechanics and enhance field recovery, and the laurels keep coming.

His home country awarded the Baltimore-based graduate of Michigan University the prestigious 1996 Nigeria Prize, Africa's top scholarly prize, while America's National Society of Black Engineers named him Pioneer of the Year.

At 41, Emeagwali has the aura of a renaissance man and is highly conscious of the example he sets to the younger generation of African American scholars.

"I work very long hours. However, I am not an obsessed sci-



Natural talent: Emeagwali says research and development at the big oil companies is conventional and rational "while my approach is multi-disciplinary, unorthodox, intuitive and nature-inspired"

Nature's own numbers man

Inspiration
from hard
history

THE DOCTOR and his wife Dale, a fellow academic,

Philip Emeagwali: Inventions

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INTERNATIONAL CONGRESS ON INDUSTRIAL AND APPLIED MATHEMATICS

Michigan University, the prestigious 1996 Nigeria Prize, Africa's top scholarly prize, while America's National Society of Black Engineers named him Pioneer of the Year.

At 41, Emeagwali has the aura of a renaissance man and is highly conscious of the example he sets to the younger generation of African American scholars.

"I work very long hours. However, I am not an obsessed scientist. As long as I am making discoveries I will continue conducting research," he says. "Otherwise I will change to a field that will use some of the transferable skills that I have acquired."

Emeagwali says the oil industry has been progressive in adapting new technologies, noting that one in 10 supercomputers is bought for use in oilfield simulation. "But at the big companies, research and development is conventional, rational and mechanistic," he laments, "while my research approach is multi-disciplinary, unorthodox, intuitive and nature-inspired."

He believes oil companies should look beyond their current reservoir simulators. "I will use my nature inspired study of the evolution of plants over the past 400 million years and the optimised branching structure of trees to design new algorithms

Nature's own numbers man

and computers that can be used to discover and recover more oil," he says.

Seeing similarities between flow patterns in reservoirs and in the oceans and atmosphere, Emeagwali claims that coming from a low-tech African environment gives him a greater appreciation of the inspiration that can be drawn from nature.

"My new discoveries are so wacky that I might be called crazy. For example, I have found that algorithms, software and computers can be enantiomeric — that is, they have left-handed and right-handed versions like shoes. I would like to apply these ideas to practical problems in the petroleum industry."

He has just formulated a mosaic-like modelling theory for parallel computing along with a

new concept for better utilising the fast calculations needed to find and recover more oil.

Emeagwali is proud of his success "as an unorthodox researcher", tying together hard-won expertise in science, mathematics, engineering and computing.

He says of his key breakthrough: "Stubborn determination was needed to continue pursuing a line of enquiry which other scientists considered crazy or foolish. No one would collaborate with me or sponsor my work but I refused to give up."

His dogged perseverance paid off. The good doctor will not put a figure on it but was amused by rumours at the time that he was worth \$200 million and was the "Bill Gates of Africa".

But Emeagwali would rather

be seen pursuing the Nobel Prize than a fat bank account. He sees himself as an innovator. "The new problem-solving approach of designing computer networks by observing and emulating patterns in nature is one that I pioneered. Mine is a logistic and inspirational approach," he says.

He attributes his success to his Igbo background in south-east Nigeria and a "can do" spirit. These are traits he wants to pass on to his young son "who is going to encounter racism in the US which will deny him the opportunity to contribute as much as he can to society".

"I want my son to be inspired by the fact that I was a high school drop-out and ex-refugee who overcame racism and made scientific contributions that benefited mankind."

Inspiration from hard history

THE DOCTOR and his wife Dale, a fellow academic, lead an annual scientific workshop for inner-city youths and he runs a website (<http://acm.org/~philip>) used as a teaching resource in US classrooms.

The mayor of a Minnesota town appointed him to a Shelter Board, which helps the homeless, and he serves on the board of the African Health Organisation.

Emeagwali was inspired by the 18th century letters of black mathematician Benjamin Banneker to Thomas Jefferson.

He says: "Banneker's amazing mathematical calculations so impressed Jefferson that he was forced to review his opinion of the intellectual capacity of Africans and urged they be freed from slavery."

Emeagwali himself appears to be making a career of overturning conventional wisdom. The scientist is currently researching a book on how the Greeks learned mathematics from Africans.

But despite his successes and evident satisfaction with his professional life, he has strong reservations about "pervasive and deeply ingrained racism" in America.

He says: "The US is one of the worst countries to live in for an ambitious black professional."

Making strides in a parallel universe

OIL COMPANIES are now pouring money into massively parallel computers — proof, says Emeagwali, that the technology has broken through initial industry scepticism.

His prize-winning work in 1989 enabled him to develop the first "pseudo-time" approach to reservoir modelling. It proved to the US establishment that "the use of only Dirichlet-type equations in the vicinity of petroleum production wells located near the boundary is better suited to

avoid the coning problems caused by the high velocity of converging flows in the vicinity of wells".

The work goes to the heart of a debate that raged in the 1930s over equations governing porous media flow modelling, and which this doughty scientist now sees good reason to revive.

Reservoir models using Darcy's 19th century equations can no longer be held valid near pumping wells with a turbulent flow regime, he claims. He also

discovered the analogy between Darcy's equations and geostrophic equations used in weather forecasting, something his industry counterparts still find hard to accept.

Uprooting old models will, he says, be costly and difficult. "Reservoir models have taken hundreds of man years and tens of millions of dollars to construct and it will be impractical to discard them. But they can be modified to incorporate the additional physics used by my new equa-

tions." He does not feel his ideas have been under-utilised by the industry and points out that his original goal was simply to demonstrate that massively parallel computers can be used to discover and recover additional oil and gas.

The next challenge, he says, will require a mix of technologies with faster computers that can perform one trillion calculations per second — a feat, Emeagwali predicts, that will be achieved in less than two years.

Philip Emeagwali: Inventions

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The International Congress on Industrial and Applied Mathematics (ICIAM) is the Olympics of applied mathematics. It's held every four years. Philip Emeagwali was invited to present his system of coupled, nonlinear partial differential and algebraic equations that he solved across a global network of 65,536 computers.

Philip Emeagwali: Inventions

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The Second Law of Motion, without the fourth of force, was integrated with the Laws of Conservation of oil and gas and their equations of states to obtain the following:

$$\nabla \cdot [\lambda_o K (\nabla P_o - P_o g)] = \frac{\partial}{\partial t} \left(\frac{\Phi S_o}{B_o} \right) + q_o,$$

oil phase pressure

oil density volumetric production rate per unit oil reservoir volume ~~that's~~

negative

permeability which is a function of x

①

$$\nabla \cdot [\lambda_w K (\nabla P_w - P_w g)] = \frac{\partial}{\partial t} \left(\frac{\Phi S_w}{B_w} \right) + q_w,$$

water phase saturation

constant rock porosity gravitational acceleration vector

②

negative when injecting water into reservoir.

$t > 0$,

$$x = (x, y, z) \in \Omega,$$

Two PDEs (above); Four unknowns S_o, S_w, P_o, P_w ; Use "Simultaneous Solution Method" to solve all four equations, boundary conditions and initial conditions

$$P_{cow} = P_o - P_w = f(S_w),$$

④

$$I.C.s. \quad P_L(x, y, z, 0) = P_L^0(x, y, z), \quad x \in \Omega$$

B.C.s. $\Delta P_L = 0$ Use ③ and ④ to remove saturations in ① and ② which then contains only oil pressure (P_o) and water pressure (P_w)

2-11-24

Philip Emeagwali: Inventions

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Philip Emeagwali lectured at ICIAM 91 on July 9, 1991 in Washington, D.C. on a minisymposium on porous media modeling.

Despite its complexity and stature as one of the seven Millennium Problems of mathematics, the Navier-Stokes equation is simply a sequence of symbols split into left and right sides joined by an equal sign—a more esoteric way of saying the F=ma in high school physics textbooks.



Both Gordon Bell Prize Winners Tackle Oil Industry Problems

At his July 9, 1991 lecture at the International Congress for Industrial and Applied Mathematics, Philip Emeagwali said:

**"I write on the board
the actual equations used by Exxon
(now Exxon Mobil)
to simulate the flow of oil, water, and gas**

inside its reservoirs.

**I argued that mathematics
is based on reasoning, not reckoning.**

**I discovered that the reverse holds
for engineering.**

**As a result, petroleum engineers
did not understand the context
of their reservoir simulators.**

**From reasoning, I discovered
a critical error
in the 160-year-old equations
used to extract oil.**

**Errors are hard to correct,
but a century and a half old error**

**overlooked by seven generations
of mathematical and computational physicists
has more lives than a cat."**

At his July 9, 1991 lecture at the International Congress for Industrial and Applied Mathematics, Philip Emeagwali said

**I discovered a century and half old
mathematical error.

I discovered and corrected the error
in the critical equations
used to extract oil and gas
by emphasizing insight over formulas,
explanations over assertions,
critical thought over methodology,
and curiosity over virtuosity.**

**I corrected the critical errors
with equations founded on 'only if'
rather than 'if only'
the inertial forces did not exist."**

At his July 9, 1991 lecture at the International Congress for Industrial and Applied Mathematics, Philip Emeagwali said:

**"Mathematics is pursued through symbols,
not words.**

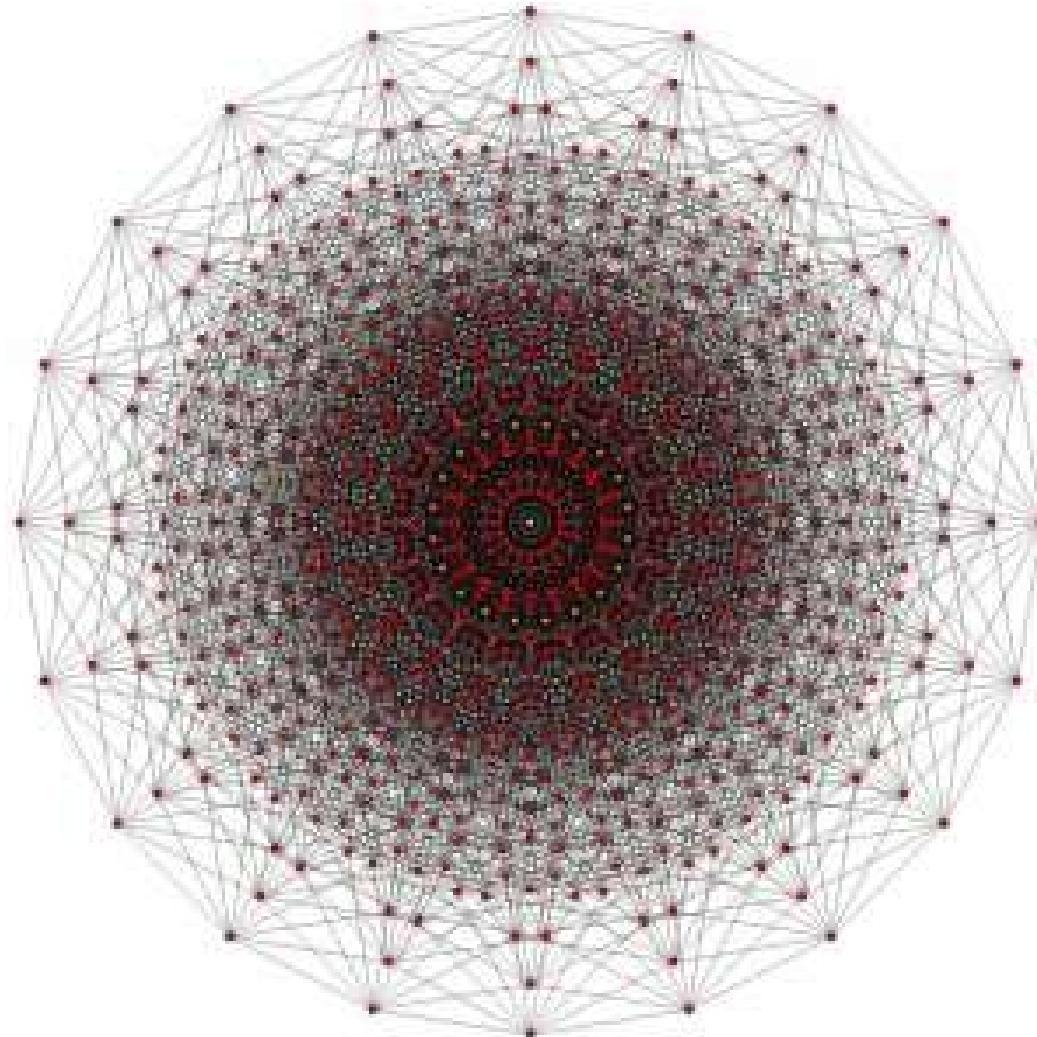
**The above is a typical page
from my mathematical research notebooks.
For me, there was an organic interplay
between physics and mathematics,
but my goal was to broaden mathematics
from the practical to the precious.
It's value increases when calculus**

**migrates from the blackboard
to the motherboard
that is redefined as an ensemble of
65,536 computers
connected as an internet.**

**The minute analyses to the micro level
of all the equations and algorithms
I developed
consumed ten years of my life
and over a thousand pages."**

Philip Emeagwali: Inventions

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Philip
Emeagwali's topological visualization of his hyper-global network of computers in a ten-dimensional

Philip Emeagwali: Inventions

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hyperspace.

Philip Emeagwali: Inventions

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Without my 72 differential and difference terms that represent the temporal and convective inertial forces, the Second Law of Motion is violated. And these equations become less effective as the propagate critical errors, which, in turn, reduces the amount of oil recovered.

Then the linearized eqn 7L

Becomes P_i are the unknown vectors of grid points
@ i th horizontal or vertical Line

$$\begin{bmatrix} A_1 & B_1 & & \\ C_1 & \ddots & \ddots & \\ & \ddots & \ddots & B_{n-1} \\ & & C_{n-1} & A_n \end{bmatrix} \begin{bmatrix} P_1 \\ \vdots \\ P_n \end{bmatrix} = \begin{bmatrix} f_1 \\ \vdots \\ f_n \end{bmatrix}$$

(8)

n = number of vertical lines on i th horizontal or vertical line

Yields the pressure from different time steps. Also compute SATURATIONS from (3) 8 (4)

Each submatrix is sparse

When only 2D (x, y), then

$A_{ij} \rightarrow$ block tridiagonal *

$C_i \& B_i \rightarrow$ block diagonal *

* Each point has two unknowns and 2×2 submatrix

each line generates a tridiagonal matrix

Use red-black ordering to enable Gauss-Seidel



9-1111 24

I'm the physicist and the mathematician who told a story in which a new technology came alive through three boards: a storyboard, a blackboard, and across motherboards.

My father and I, followed by my son, broke the tradition of walking in our ancestors' footsteps. My father was a nurse, and my son and I are computer scientists. All three of us abandoned the soil to work in knowledge-based industries.

Philip Emeagwali: Inventions

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Fame attracted daily visitors and journalists to the office of Philip Emeagwali. Here he paused for photos. (Courtesy of *Detroit Free Press*, Page 1E, May 29, 1990)

I am the artist that told stories about how the Laws of Motion gave rise to the eternal truths of calculus; timeless truths that will outlast the changing opinions of all times.... and my reinvented algorithms became my fingerprints on the sands of time.

For countless centuries, my Igbo ancestors were farmers. Sons walked in their father's footsteps, ploughing the same land. Their life expectancy was about 37 years.

Daughters married early, had as many children as they could, and became young widows. My mother married days after her 14th birthday and gave birth to me six days after her 15th birthday. She was born in colonial Africa, where she counted her age on her fingers and toes and by her age-grade affiliation.

Philip Emeagwali: Inventions

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The diaries and research notebooks of Philip Emeagwali.

The Eight Continent

From the perspective ~~of~~ an alien ~~encircling~~ encircling our planet on his spaceship and from a distance of a few million miles, our Earth will be the size of an apple. And our atmosphere will be as thin as the skin of that apple.

The aliens will wonder:

"What's that electronic cloth that enshrouds that ^{planet} ~~Earth~~?"

eight-continent_1

Philip Emeagwali: Inventions

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~~best~~ In a century, I envision that

10,000 ten-thousand-mile diameter

that you today call the
electronic cloth, a.k.a. Internet,

metamorphosizing into what

our children's children ~~will~~ might

describe as a digital SuperBrain.

That is, our internet will become

their eighth continent of the 22nd

century people. It will be their

repository of their knowledge and

wisdom.

eighth-continent-2

beyond.

Philip Emeagwali: Inventions

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Transcribed from a lecture delivered by Philip Emeagwali. The video is posted at [YouTube.com/emeagwali](https://www.youtube.com/emeagwali)

The audio is posted at [SoundCloud.com/emeagwali](https://soundcloud.com/emeagwali)

SUMMARY:

The video is posted at emeagwali.com and youtube.com/emeagwali

emeagwali.com

[SoundCloud.com/emeagwali](https://soundcloud.com/emeagwali)

YouTube.com/emeagwali

A ten minute lecture (Transcript)

**“Who’s Philip Emeagwali?”
I’m the physicist**

**and the mathematician
who told a story
in which a new technology came alive
through three boards:
a storyboard, a blackboard,
and across motherboards.**

**For countless centuries,
my west African Igbo ancestors
were farmers.**

**Sons walked in their father's footsteps,
ploughing the same land.**

**Their life expectancy was about
37 years.**

**Daughters married early,
had as many children as they could,**

and became young widows.

**My mother married days
after her 14th birthday
and gave birth to me six days
after her 15th birthday.**

**She was born in colonial Africa,
in 1939,
where she counted her age
on her fingers and toes
and by her age-grade affiliation.**

**My father and I, followed by my son,
broke the tradition of walking
in our ancestors' footsteps.**

My father was a nurse, or a nursing scientist,

**and my son and I
are computer scientists.
All three of us scientists
abandoned the soil
to work in knowledge-based industries.**

**I am the artist
that told stories about how
the Laws of Motion of physics
gave rise to the eternal truths of calculus;
timeless truths
that will outlast the changing opinions
of all times....
and my reinvented equations and algorithms
became my fingerprints
on the sands of time.**

What is a supercomputer, anyway?

What makes a computer super, anyway?

*Once upon a time,
in 1988 to be exact,
the fastest computations in physics
were executed
within only one supercomputer.
In the 1980s, Seymour Cray designed
seventy percent of all supercomputers.
The Cray supercomputers of the 1980s*

**were powered by
only one extremely fast processor,
dubbed “oxen.”**

**Today, all Cray supercomputers
are powered by thousands of slow
processors, dubbed “chickens.”**

As an aside, the story is told

that back in 1914

Henry Ford

was advised to change the colors of his cars.

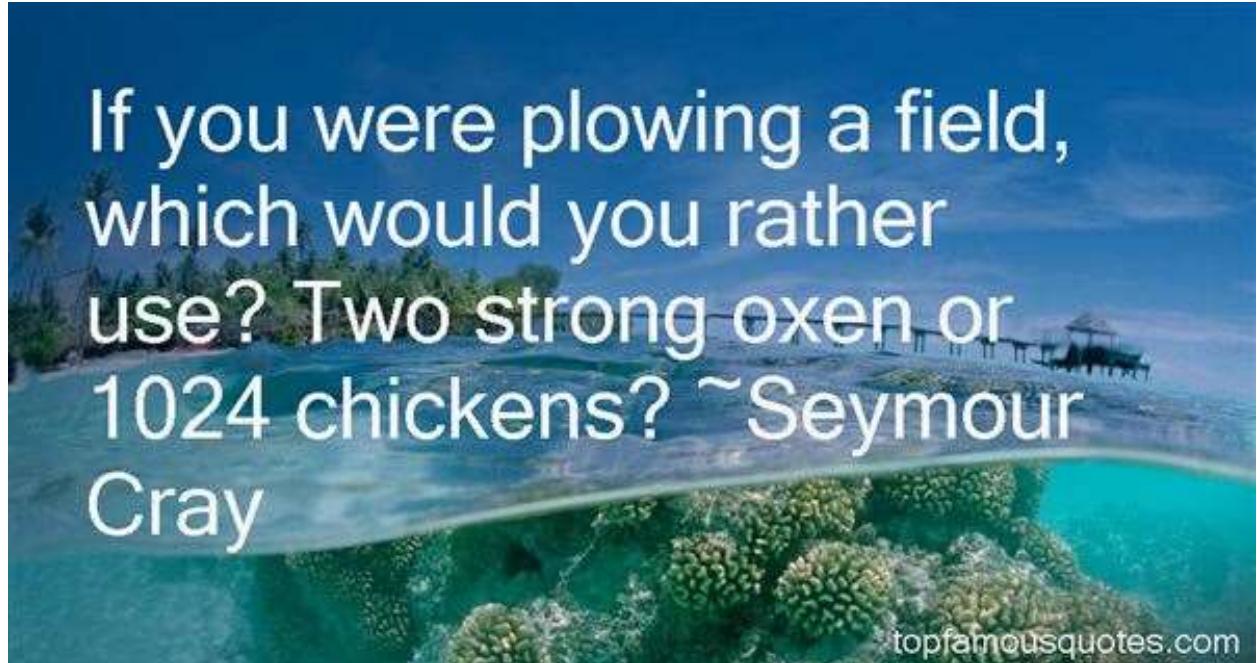
Henry Ford replied:

“Any customer

can have a car painted any color

**that he wants
so long as it is black."**

**The story is also told that
when Seymour Cray
was urged to use several processors
to power his supercomputers,
he retorted:**

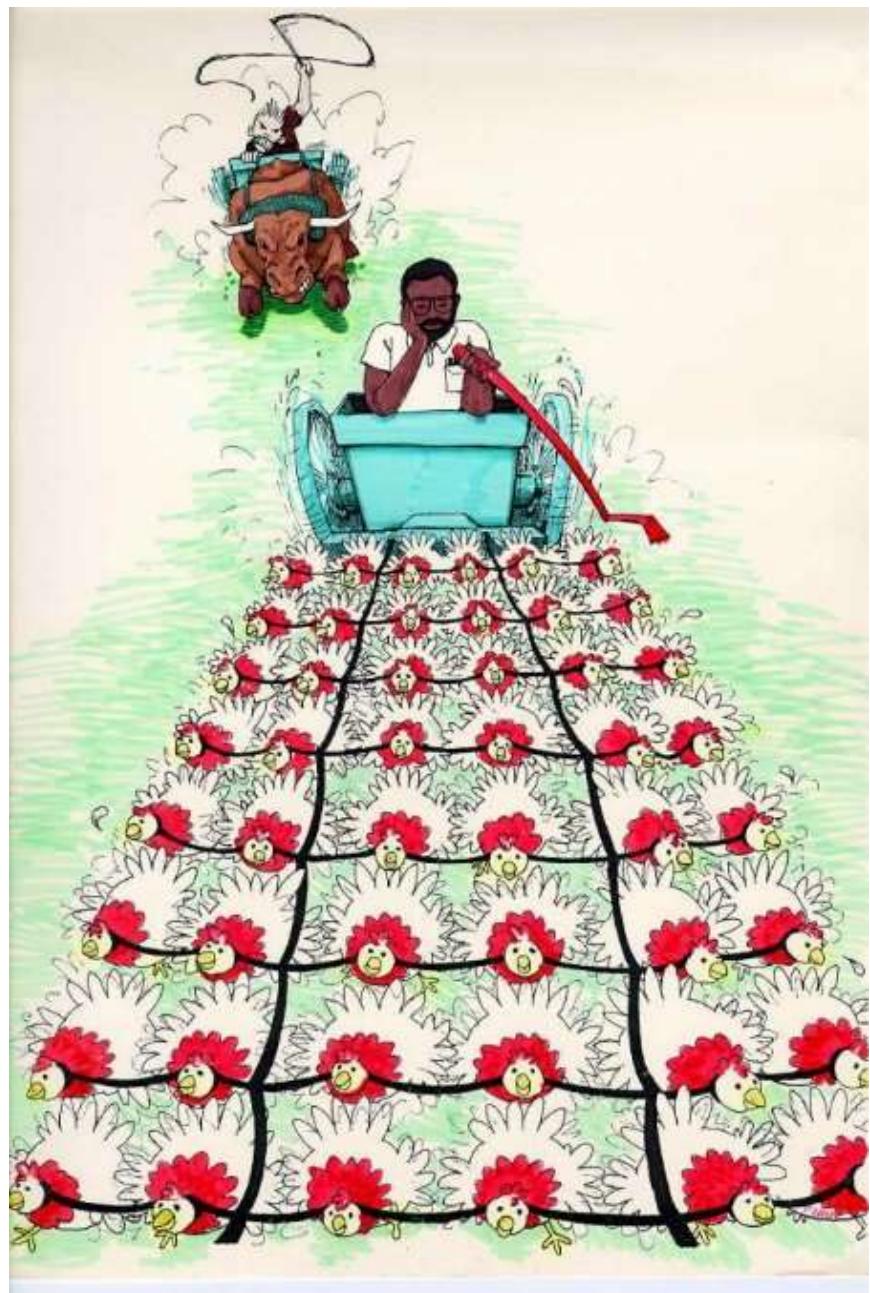


topfamousquotes.com

**But there was only one supercomputer
powered by 65,536 “chickens,”
or extremely slow processors.
During the 1980s,
I was the lone wolf 24/7 programmer
of the first and only
65,536-processor powered supercomputer.**

Philip Emeagwali: Inventions

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**I was called “insane”
for spending a decade
on the impossible.**

**That machine was abandoned because
Amdahl's Law
described in supercomputer textbooks
decreed that
it will forever remain impossible
to achieve a speedup of more than eight
with eight or more processors.**

**In the November 29, 1989 issue
of *The New York Times*,**

**Neil Davenport, the president
of the Cray Computer Corporation
—the sister company to the company that
manufactured seven in ten
supercomputers—warned,
"We can't find any real progress
in harnessing
the power of thousands of processors."
Cray Research President John Rollwagen
in a UPI (upi.com) article dated September 2,
1985,
described the use of 64 processors as:
"more than we bargained for."
After it was discovered that**

**the seemingly impossible is, in fact,
possible,**

**Nine in ten supercomputers
are used to solve grand challenge problems
in computational physics,
such as recovering petroleum
or foreseeing global warming.**

**If nine in ten supercomputer cycles
pertained to physics,
then the supercomputer is an instrument of
physics.**

**One in ten supercomputers are used
to discover and recover oil.**

The fastest supercomputer

costs up to two billion dollars.

It's powered by more than one million computers.

I discovered

how to use a global network of

65,536 computers

as a supercomputer

that is an internet

to discover and recover more oil and gas,

both offshore and onshore.

In 1989, it made the news headlines that I,

the "African Computer Wizard,"

discovered how to speedup 180 years,

**or 65,536 days,
of computations within one computer
to only one day
of computations across a global network of
65,536 computers.**

**I was the first and lone wolf programmer
because it was then the *terra incognita*
of the fastest recorded computations
in physics.**

**I wanted to travel uncharted territories
in human knowledge,
and to specifically push the frontiers of
calculus**

**and the fastest computers
and use both as instruments of
the fastest computations
in physics.**

**My contributions to mathematical physics
is my discovery of thirty-six errors
that corresponded to
thirty-six partial derivative terms
that represented
the components of the temporal
and the convective inertial forces
for the flow of oil, water, and gas
in the temporal and the three spatial
directions.**

**Those thirty-six mathematical errors
were critical because they occurred
within the nine systems of coupled,
nonlinear partial differential equations.**

**Those erroneous equations
were used within the petroleum industry
and used for sixty (60) years
to simulate the subterranean motions of
oil, water and gas
from water injection wells
to oil and gas production wells.
I corrected the mathematical error
by balancing the forces so that
Force equals mass times acceleration
at all times and places,
from the storyboard to the blackboard
to the motherboard,
and across motherboards.
I also balanced the systems of differential
and algebraic equations
that arose from the Second Law of Motion**

of physics.

**A balanced equations yields
more accurate hindcasting
making it easier to extract more oil and gas.**

**In my search—or re-search—
for new partial differential equations of
calculus,**

I used the arsenal of rationality

to search for order

within apparent chaos,

to draw analogies

between different phenomena,

to reduce complex systems

to their core essences,

to make a connection

between the laws of physics

and the partial differential equations of calculus.

In that theoretical re-search for new mathematical physics, I experimentally discovered how to harness the power of 65,536, or two-to-power sixteen, computers that were distributed equal distances apart on the surface of a globe in the sixteenth dimension.

That is, execute heavy-duty computing by splitting one grand challenge problem into 65,536 initial-boundary value problems and across as many computers.

That discovery is my contribution to computational physics.

I discovered how to program

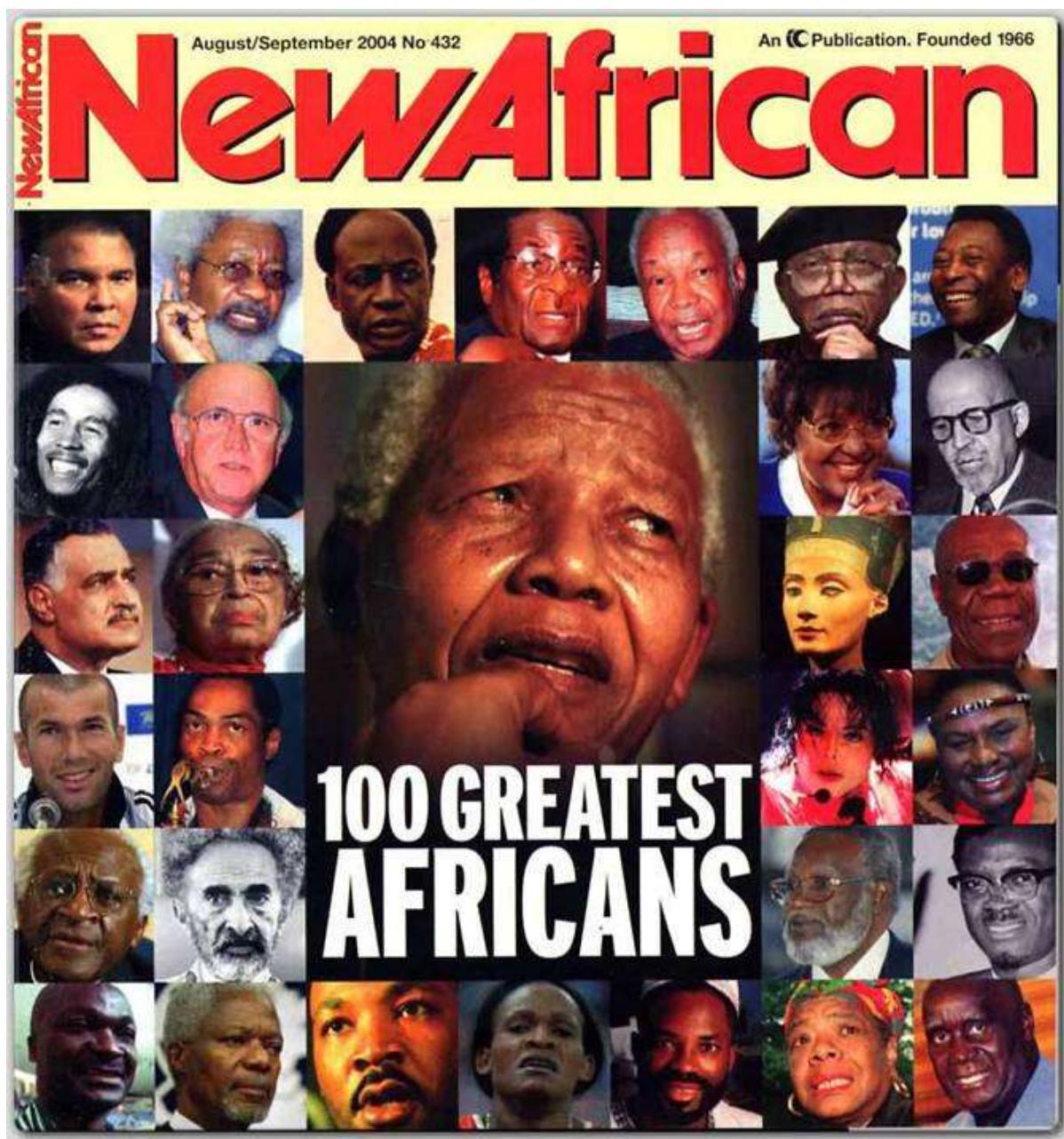
a primordial internet
as one cohesive, seamless unit
that emulates one supercomputer
that solves a one computation-intensive
initial-boundary value grand challenge
problem,
such as a global circulation model
that could be used to foresee
unforeseen global warming.
I discovered how to reduce
computations that took
one hundred and eighty [180] years,
or 65,536 days, within one computer
to only one day across
65,536 computers.

I discovered
one hundred and eighty [180] years
in one day....

Philip Emeagwali: Inventions

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1,000 pages of transcribed lectures is forthcoming.



Philip Emeagwali: Inventions

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