



The Future Ain't What it Used to Be

Domenico Grasso
The University of Delaware



14 April 2016

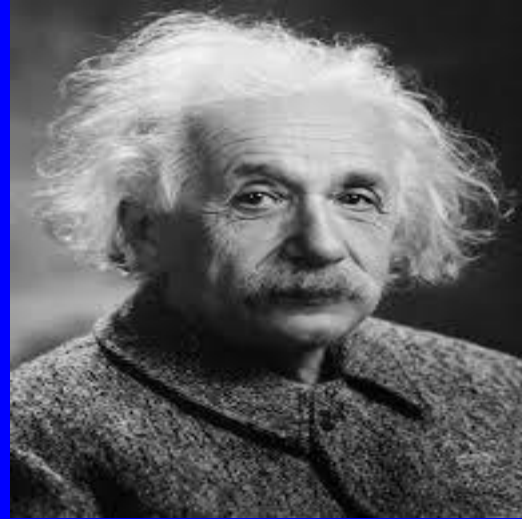


RADM Robert C. Williams

Kristin Morico



Einstein



Pascal



Newton



PLAY





The Power of Engineering Thought

Greatest Engineering Achievements OF THE 20TH CENTURY

◆ About ◆ Timeline ◆ The Book

Welcome!

How many of the 20th century's greatest engineering achievements will you use today? A car? Computer? Telephone? Explore our list of the top 20 achievements and learn how engineering shaped a century and changed the world.

- | | |
|--|--|
| 1. Electrification | 11. Highways |
| 2. Automobile | 12. Spacecraft |
| 3. Airplane | 13. Internet |
| 4. Water Supply and Distribution | 14. Imaging |
| 5. Electronics | 15. Household Appliances |
| 6. Radio and Television | 16. Health Technologies |
| 7. Agricultural Mechanization | 17. Petroleum and Petrochemical Technologies |
| 8. Computers | 18. Laser and Fiber Optics |
| 9. Telephone | 19. Nuclear Technologies |
| 10. Air Conditioning and Refrigeration | 20. High-performance Materials |



Engineering

en·gi·neer·ing _ P **Pronunciation Key** (n j -nîr ng)

n.

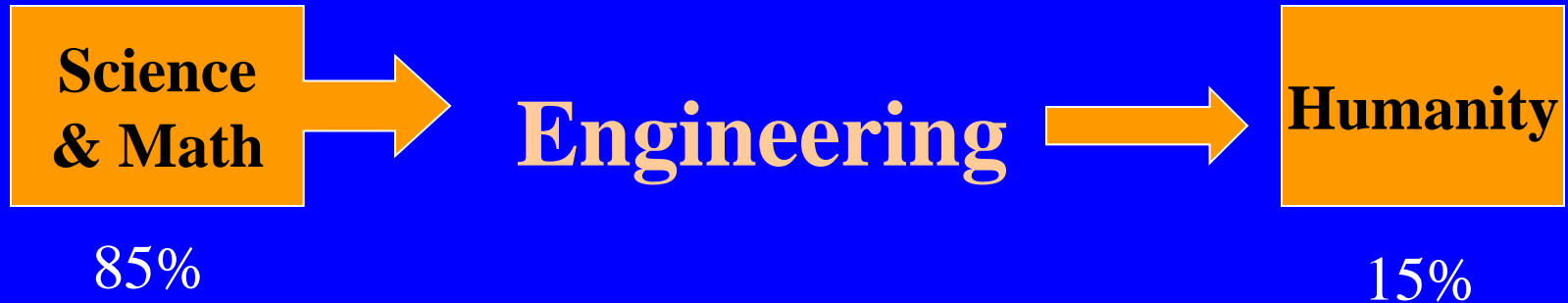
- » The application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems.

 Dictionary.com



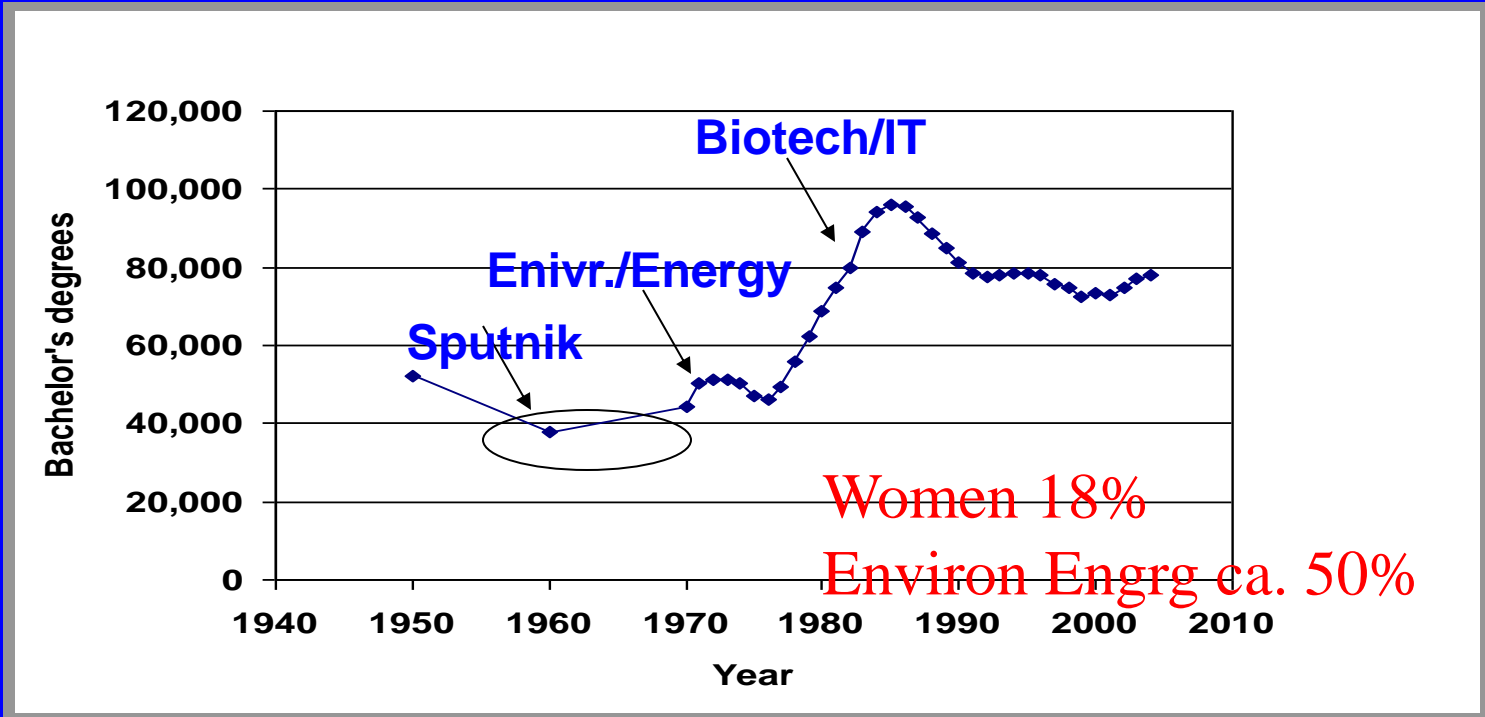
Traditional Engineering

• **Linear** →



“If it weren’ t for the people...always getting tangled up in the machinery...the world would be an engineer’ s paradise.”

US Bachelor's Degrees in Engineering by Year



Traditional Education

Concept of equality

$$2 + 2 = 4$$

Satisfaction

13

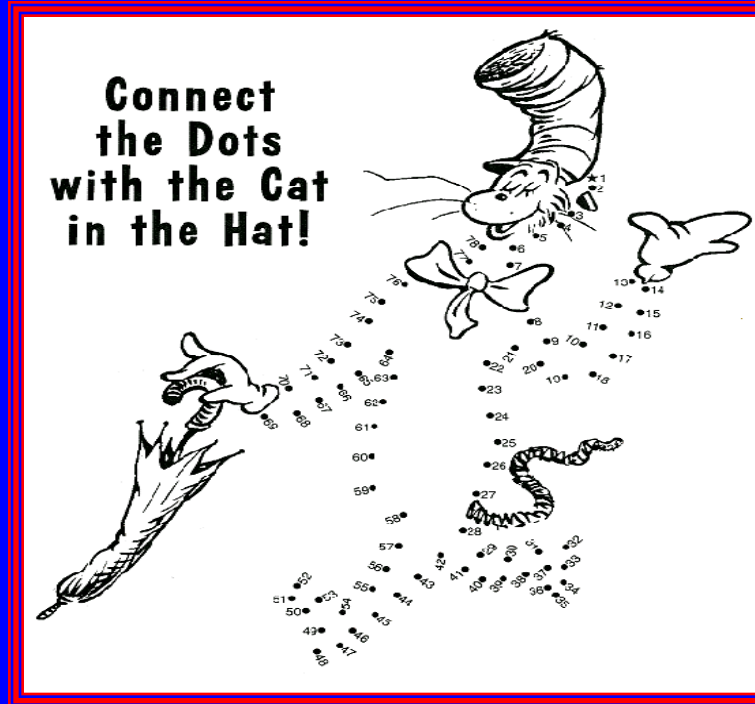
-8

Algorithm Paralysis

1,000,003

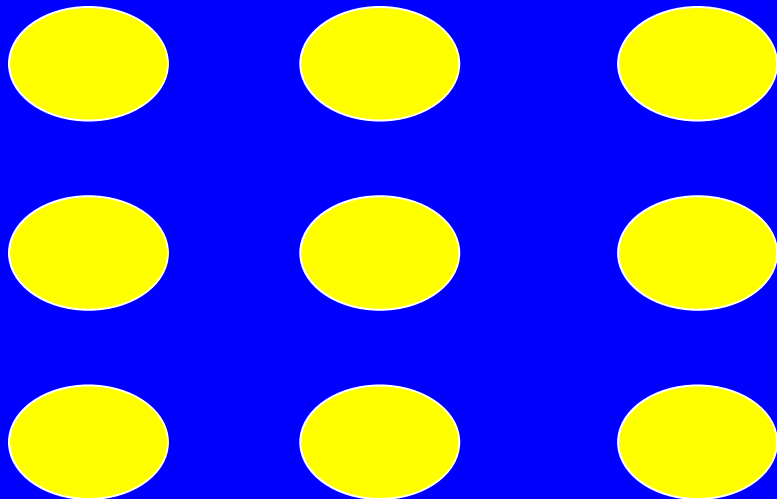
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The traditional approach to technological education starts when we are young



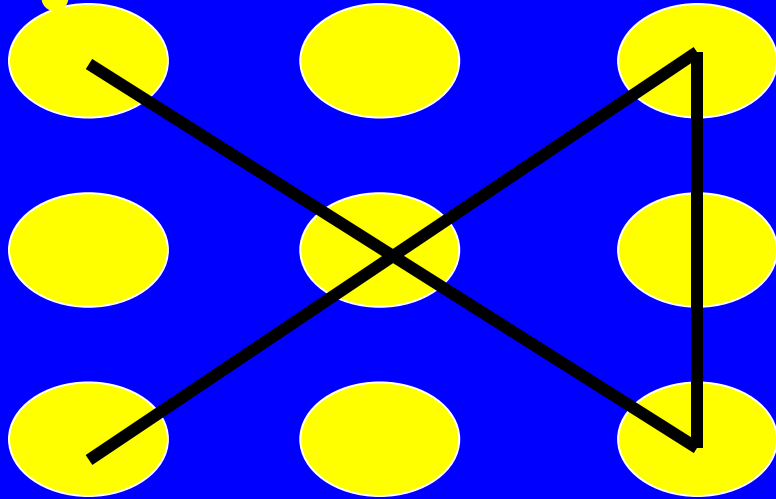
The real world is more like this

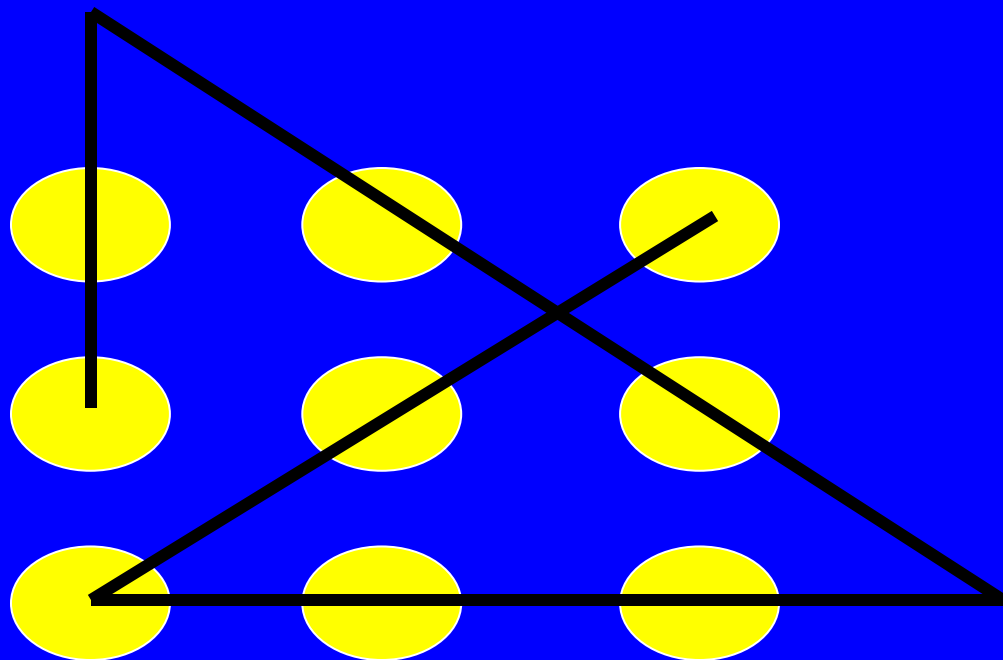
Without lifting pen from paper,
connect the dots with four lines

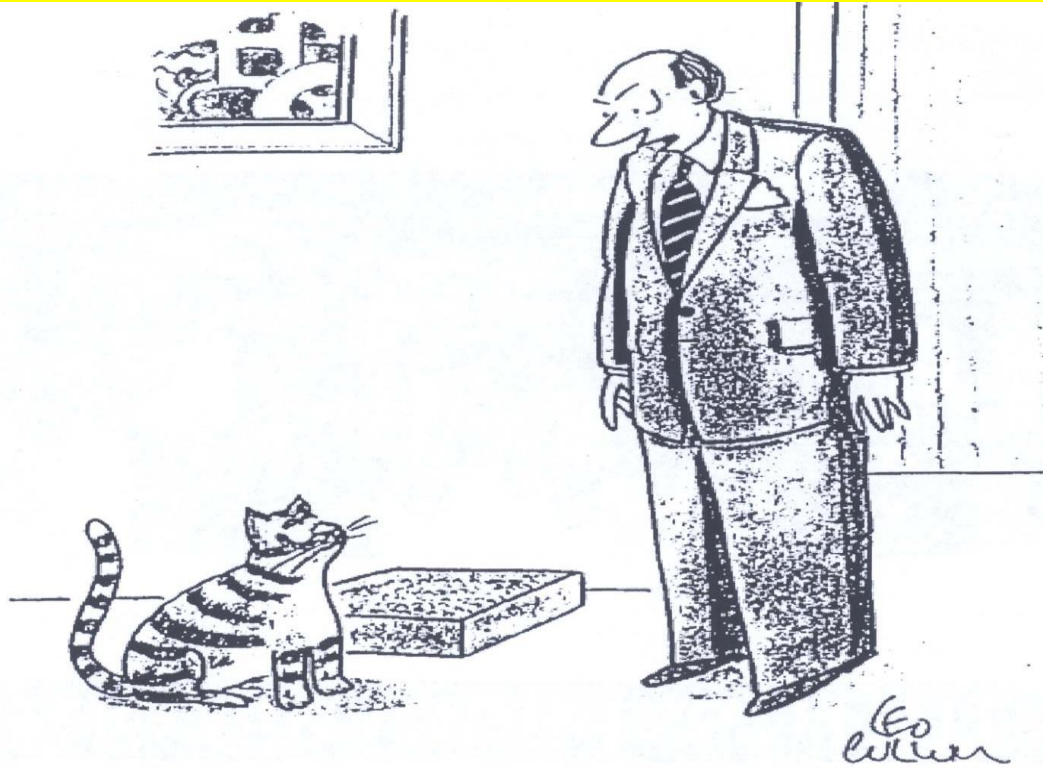


?!?!?

Algorithm Paralysis







"Never, ever, think outside the box."

Bioengineering Feats

npr 4:30 Hourly News Summary 4:30 24-hour Program Stream Schedule Search NPR.org go

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Tell Me More
Wait Wait...Don't Tell Me
Weekend Edition Saturday
Weekend Edition Sunday
Music Programs
All Songs Considered
From the Top
JazzSet
Marian McPartland's Piano Jazz

HEALTH & SCIENCE
Minty E. Coli and Other Bioengineering Feats
by Robert Krulwich
Listen Now [6 min 43 sec] + add to playlist



Enlarge *Heather A. Thomson*
This MIT research team created the world's first mint- and banana-scented E. coli bacteria. Stephen Payne (from left), Boyuan Zhu, Tom Knight, Reshma Shetty, Andre Green, Veena Venkatchalam, Samantha Sutton, Jason Kelly, Austin Che, Barry Canton, Kate Broadbent.

The Research
» The MIT Team's E. coli Project (PDF)

'We Are Bioengineers'
The Radio Lab program includes a celebration of bioengineering from one of the world's most famous and lauded scientists, physicist Freeman Dyson, speaking at the University of Michigan. With tongues very much in cheeks, Jad Abumrad and Robert Krulwich asked Josh Kurz and Shane Winter to compose an anthem to go along with Dr. Dyson's dream-like rhetoric.
The result is a musical salute, "We Are Bioengineers," music by Shane, lyrics (and singing) by Josh and their Mammalian Pituitary Band (Jason Major, Wendy Roderweiss, vocals; Natasha Bayus on french horn). If there were a Grammy in the Science Marching Band category, they would — all of them — be kings.

» Listen: 'We Are Bioengineers' [1 min 16 sec] + add

Previously on 'Morning Edition'
March 6, 2008
» Radio Lab: Into the Brain of a Liar

Morning Edition, April 29, 2008
Engineers build bridges, buildings, roads, structures that shelter us and help us move around. But now there's a new class of engineer. These folks build living things.
They call themselves "bioengineers." Instead of cement and mortar and brick, they work with organic chemicals to make changes in living things, to create new kinds of life. And, though this is still a distant goal, one day they might build life from scratch, from non-life.
In short, bioengineers are the space cadets of engineering, going boldly where no engineers have gone before, and they seem to be having a remarkably good time, to a degree that worries some traditional biologists and a few cranky journalists.
Scientists all over the world are changing and rearranging living creatures for all kinds of reasons, some silly, some profound.
Humans have been doing this for centuries, of course, using the breeding techniques that have produced Chihuahuas and poodles, and different varieties of apples and bananas, but bioengineering, tinkering with the DNA, produces those changes much more quickly.
Stinky E. coli
At MIT, students were assigned to work with a bacteria called E. coli. It's a well-known, lab-friendly organism, used by students everywhere. Problem is, it smells. E. coli is, says an undergraduate named Steve Payne, "poopy." Who wants to spend hours in a room with a rapidly multiplying poopy neighbor? Not Steve. Not his classmates.

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Lucy's I laugh Enlivens the



Engineering Education

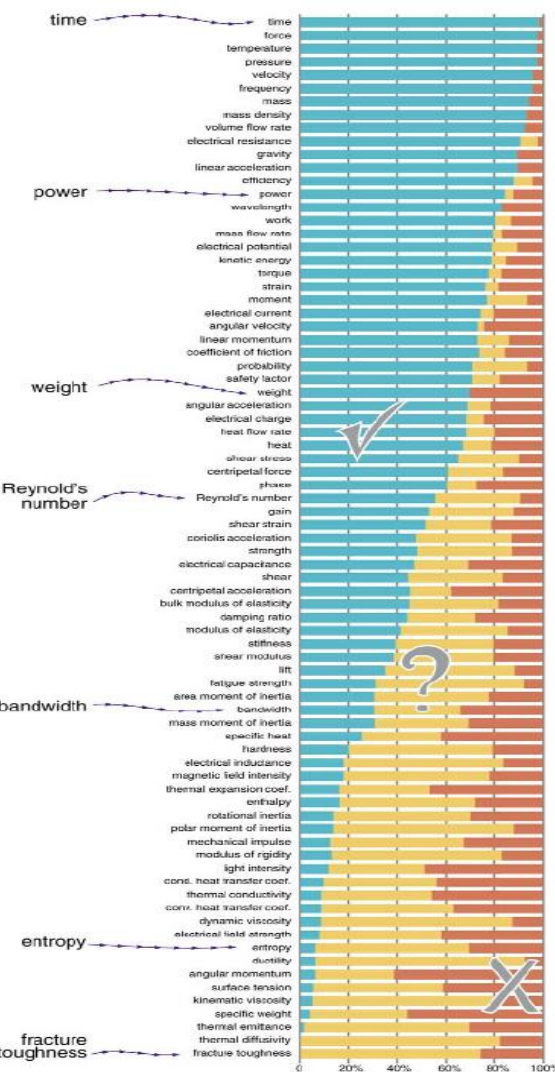
Focused on How We

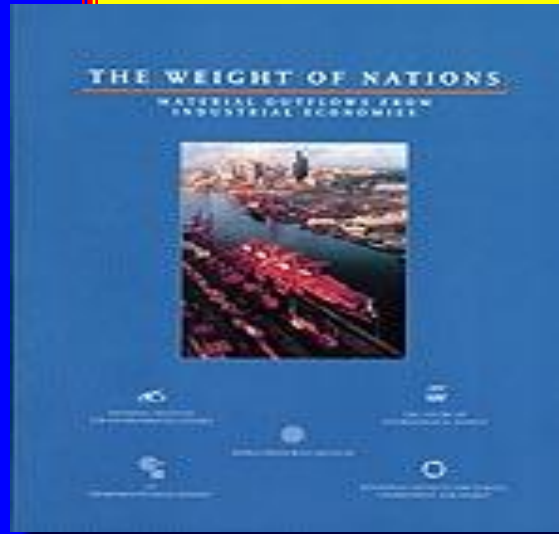
Teach

Rightfully so

- 120 MIT ME Seniors
- Provide Units

Source: Woodie Flowers, "New Media' s Impact on Education Strategies"
<http://www.educause.edu/ir/library/pdf/ffpiu016.pdf>





Austria

Germany

Japan

Netherlands

United States

Key Finding:

- Between 1/2 and 3/4 industrial inputs are returned to the environment as waste within *1 year!*

Technological Algorithm Paralysis

“Anthropogenic Impact on
Global Geodynamics Due
to Reservoir Water
Impoundments”



Benjamin Fong Chao, NASA

Geophysical Research

Letters

Length of a day -8×10^{-6} sec
22 (24): 3529-3532, 1995

Today's problems come from yesterday's solutions.

Peter M. Senge, "The Fifth Discipline"



The Bridge

The greatest enterprise of the mind has always
been and always will be the attempted
linkage of the sciences and humanities

E.O. Wilson, Harvard, 1998

Engineering

Application of science and math to serve
humanity



Engineering Education Paradigms

- | **Pre-1950**: Focus on engineering practice; design according to codes and well-defined procedures; limited use of mathematics; many faculty with industrial experience and/or strong ties with industry
- | **1950-2000**: Focus on engineering sciences; fundamental understanding of phenomena; analysis; majority of faculty trained for academic research
- | **2000-?**: Focus on holistic solutions; integration; innovation; entrepreneurship; communication and policy; design: making things: complex systems

Training and/or Education

Training



How to do

Develop contextual skill for enhancing immediate productivity



Education

How to think and create

Develop conceptual skill for thinking beyond the prevailing paradigm

Shift to Services

Top Ten Nations by Labor Force Size (about 50% of world labor in just 10 nations)

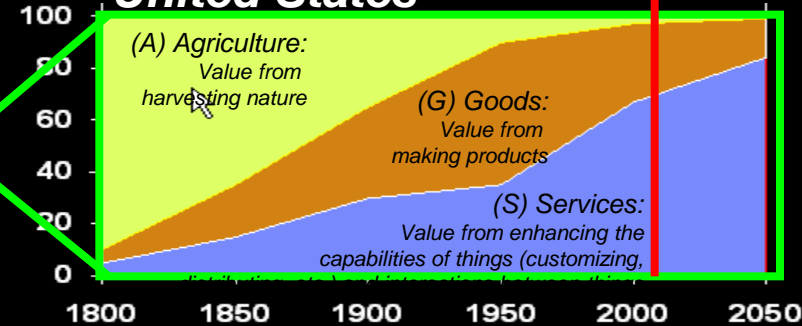
A = Agriculture, G = Goods, S = Services

Nation	% ww Labor	% A	% G	% S	25 yr % delta S
China	21.0	50	15	35	191
India	17.0	60	17	23	28
U.S.	4.8	3	17	80	31
Indonesia	3.9	45	16	39	35
Brazil	3.0	23	24	53	20
Russia	2.5	12	23	65	38
Japan	2.4	5	25	70	40
Nigeria	2.2	70	10	20	30
Banglad.	2.2	63	11	26	30
Germany	1.4	3	33	64	44

2016

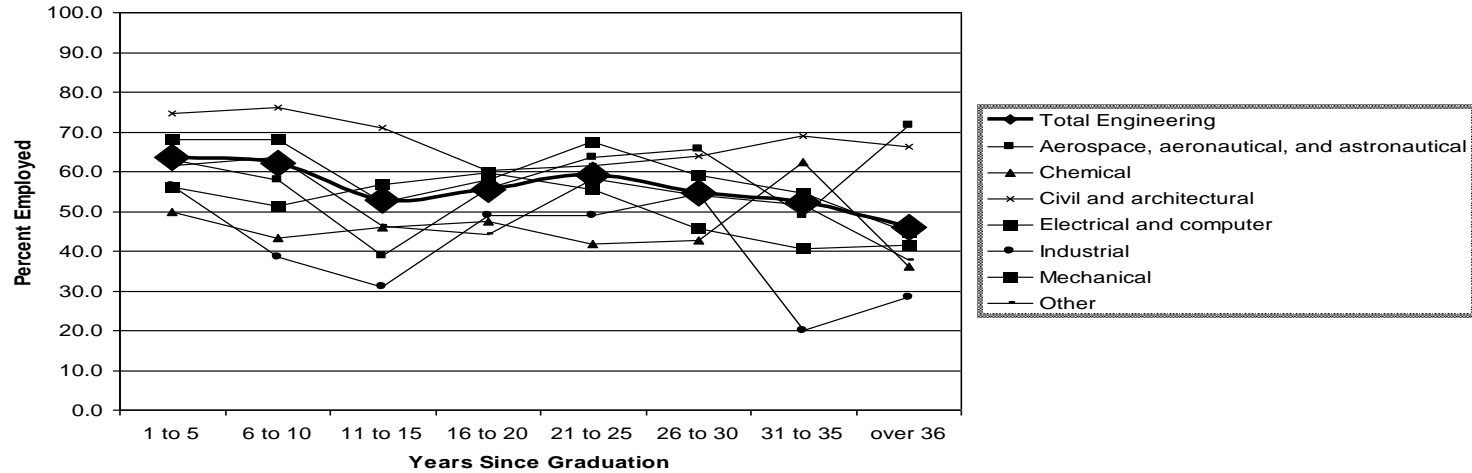
United States

2016

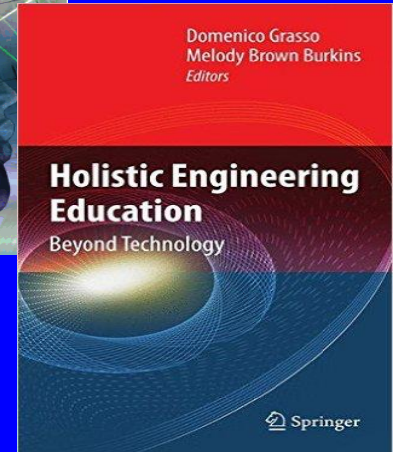
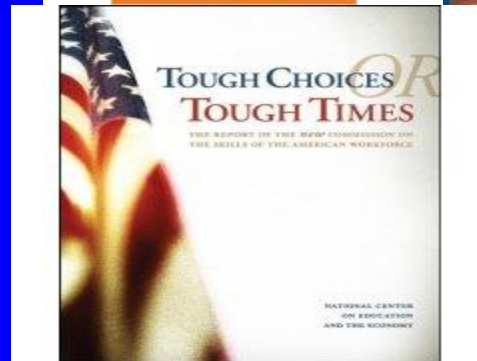
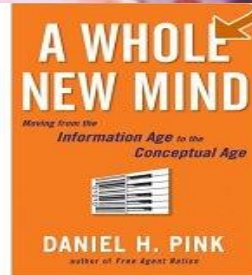
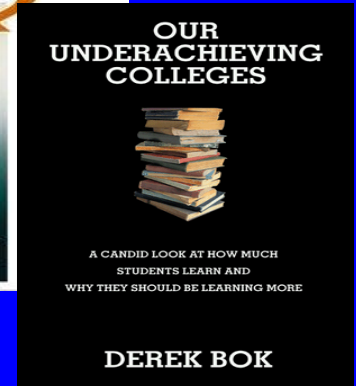
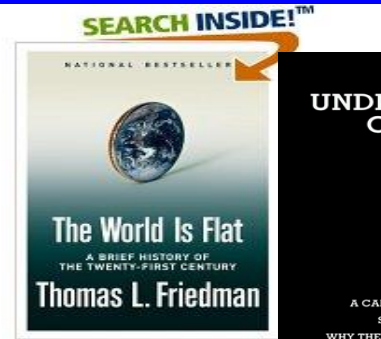


The largest labor force migration in human history is underway, driven by global communications, business and technology growth, urbanization and low cost labor.

>50% (S) services, >33% (S) services



Employed individuals with engineering highest degrees whose jobs are closely related to field of highest degree, by years since degree



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HOLISTIC ENGINEERING EDUCATION SUMMIT MARCH 21-23, 2016

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Welcome to the first Holistic Engineering Education Working Group Summit sponsored by the **Department of Technology and Society** at Stony Brook University in conjunction with Purdue University Press.

We have gathered an unprecedented group of thought leaders from around the globe to begin to discuss ways to transform engineering education through Holistic Engineering Education in order to meet the challenges of the 21st century and beyond.

Summit Logistics

Dates: March 21st - 23rd 2016

Location:

Stony Brook Manhattan

387 Park Avenue South - 3rd Floor

New York, NY 10016



Harvard University

It does **not** define intellectual breadth as the mastery of a set of Great Books, or the digestion of a specific quantum of information, or the surveying of current knowledge in certain fields. Rather, the Core seeks to introduce students to the major *approaches to knowledge* in areas that the faculty considers indispensable to undergraduate education. It aims to show **what kinds of knowledge and what**

Core Program



Forward Thinking Engineers Respond

The center of gravity for innovation is shifting from solving narrow problems focused primarily on technology


to
issues and opportunities

Technology is not Enough

IBM



Depth and Breadth



Science and Engineering

Complexity / Systems Engineering

Computer Science & Info. Systems

Math and Operations Research

*Humanities, Social Sciences, Arts
Global Perspective*

Organizational Change & Learning

Business and Management

The Age of Complexity



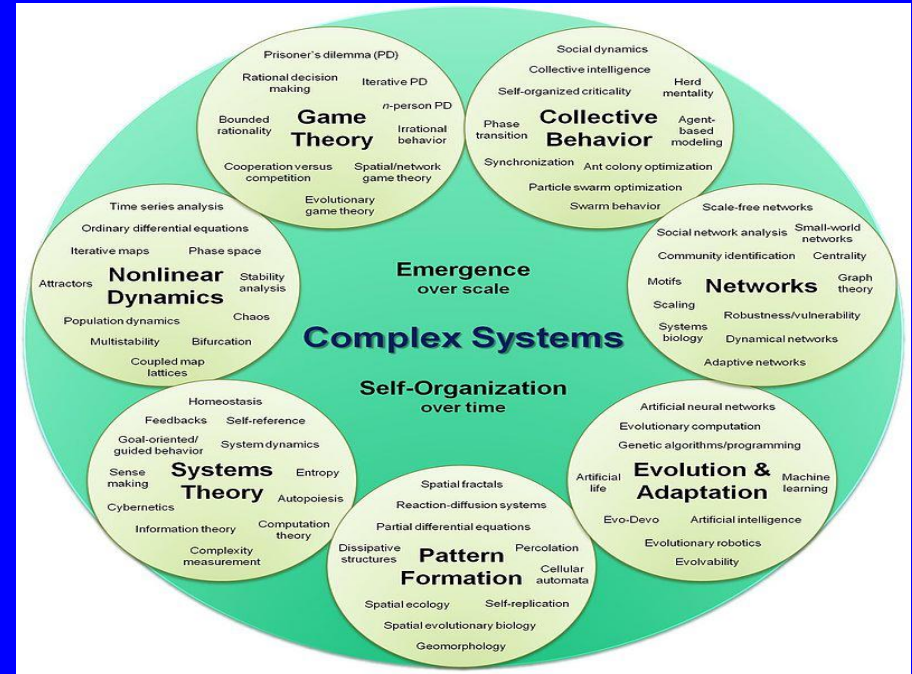
“The greatest challenge today ... is the accurate and complete description of complex systems.

Scientists have broken down many kinds of systems. ...

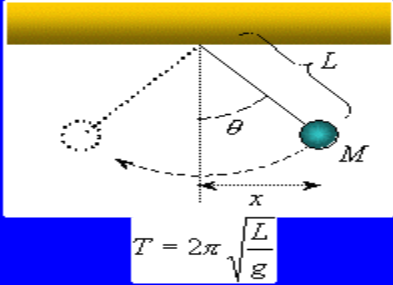
The next task is to reassemble them, ... that capture the key properties of the entire ensembles.”

Holistic Perspective & Complex Systems

- Emergent Behavior
- Sometimes adaptive
- Cannot predict from constitutive parts
- Examples
 - Environment
 - Economy
 - Terrorism



Simple, Complicated, Complex

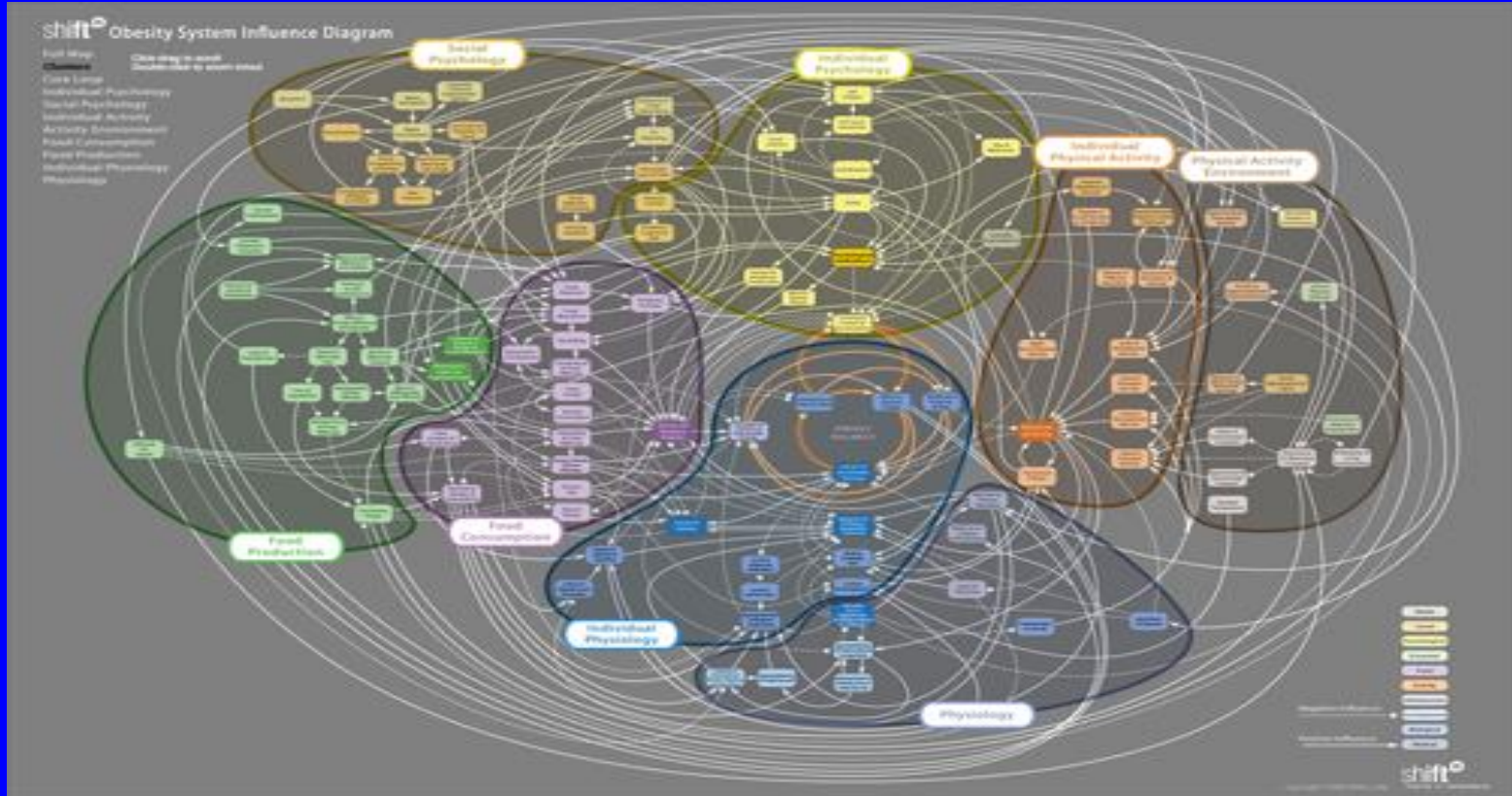


Simple

Complicated

Complex

Obesity as a Complex System



Complexity and Holistic Thinking

- “The next century will be the century of complexity.”



Stephen Hawking

- “Chance favors the prepared mind.”



Stockholm Traffic Problem



[http://www.seedforum.org/userfiles/Stockholm\(1\).jpg](http://www.seedforum.org/userfiles/Stockholm(1).jpg)

14 Islands 57 Bridges

Another Bridge??



<http://bridgepros.com/projects/TacomaNarrows/TacomaNarrows.htm>

Holistic Solution

Results



1. Traffic at cordon points reduced by 100,000 vehicle passages per day or 25%
2. Train and transit passengers increased by 40,000 per day
3. Congestion during peak hours dramatically reduced
4. No major re-routed traffic problem
5. Time tables for inner city bus lines have to be redesigned due

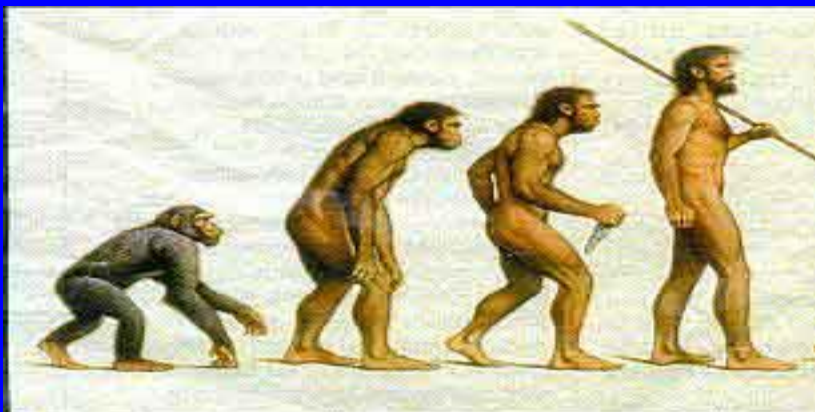
Other Examples

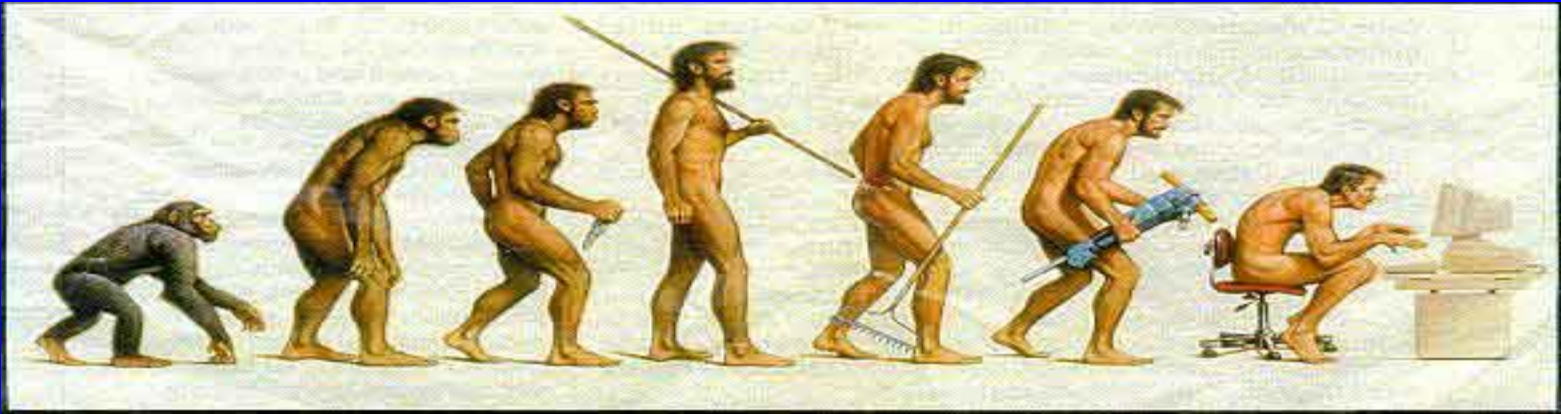


Speed Camera Lottery

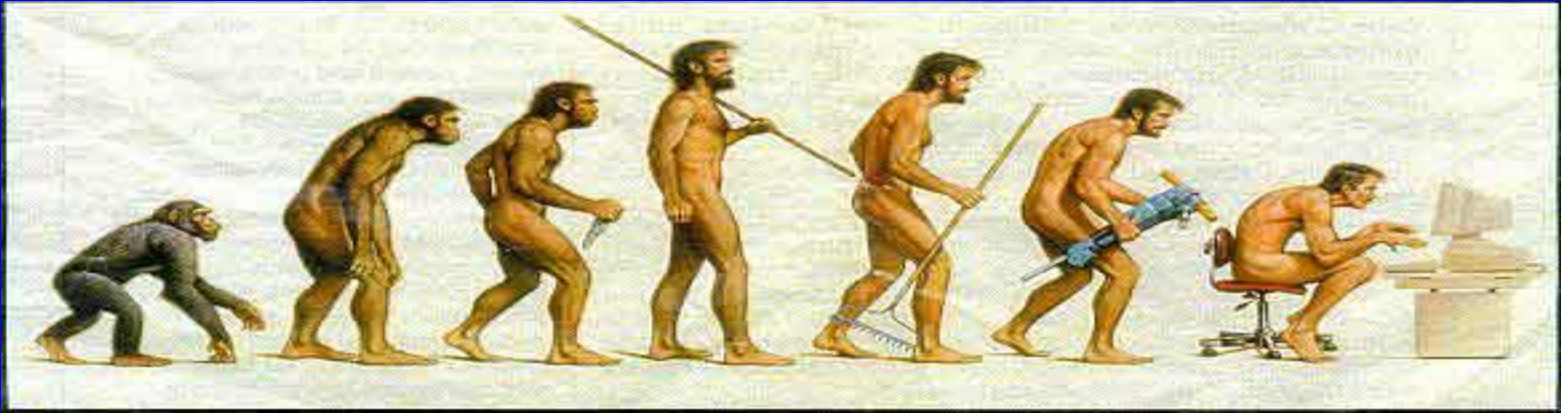


Shared Space ...
Controlled Chaos





“The world we have created has problems that cannot be solved thinking the way we used to think when we created them”



“The future ain’ t what it used to be.”

Yogi Berra



GRAND CHALLENGES FOR ENGINEERING



Make solar energy
economical



Provide energy
from fusion



Develop carbon
sequestration
methods



Manage the
nitrogen cycle



Provide access to
clean water



Restore and
improve urban
infrastructure



Advance health
informatics



Engineer better
medicines



Reverse-engineer
the brain



Prevent nuclear
terror



Secure
cyberspace



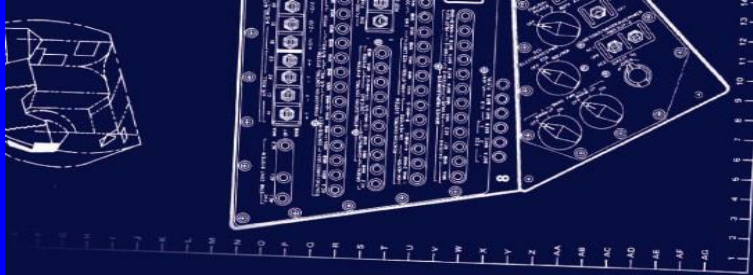
Enhance virtual
reality



Advance
personalized
learning



Engineer the tools
of scientific
discovery



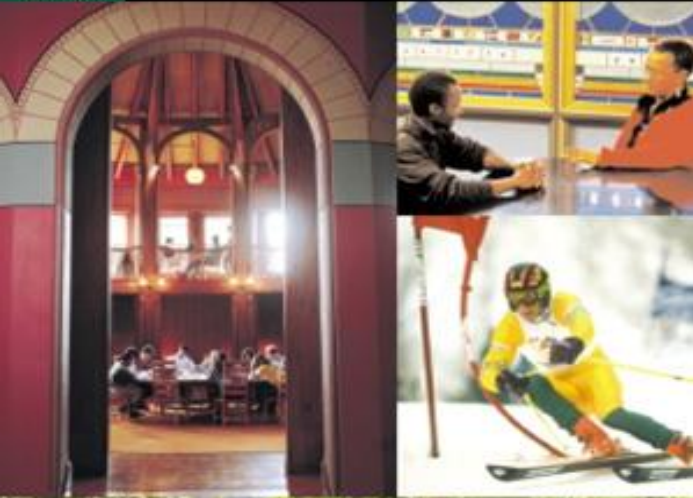
Realizing the
power of
engineering
thought

Maybe next time...

**Thank God we are in the
hands of engineers!!**



The University of Vermont



Beyond Technology

The Future of Engineering

Domenico Grasso, Ph.D., P.E., DEE
Vice President & Dean



Benton Lecture
University of Florida
24 February 2011

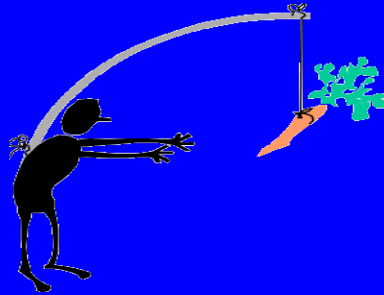
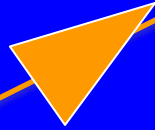
Motivation

Currency

Luxury

Pressure

Legacy



PLAY





The Power of Engineering Thought

Greatest Engineering Achievements OF THE 20TH CENTURY

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Engineering

en·gi·neer·ing _ P **Pronunciation Key** (n j -nîr ng)

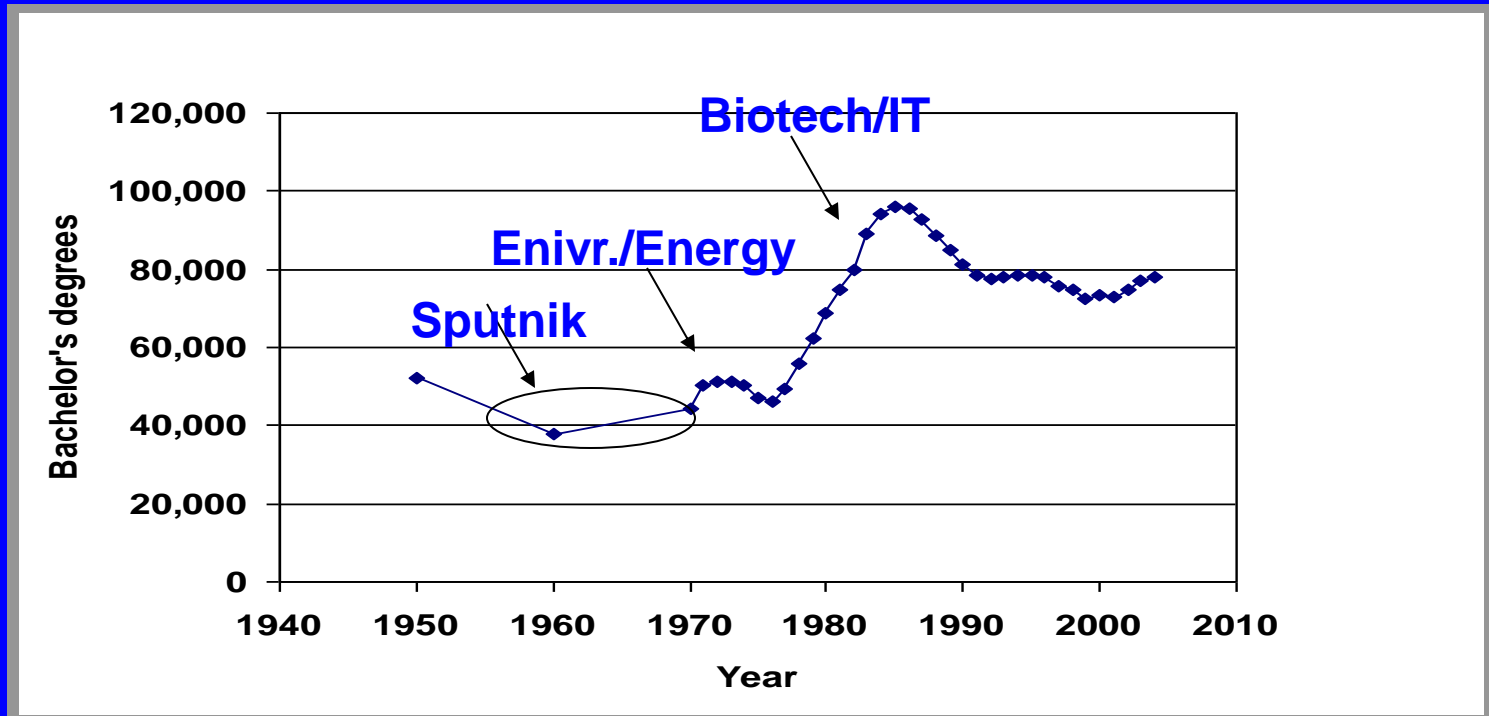
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 Dictionary.com



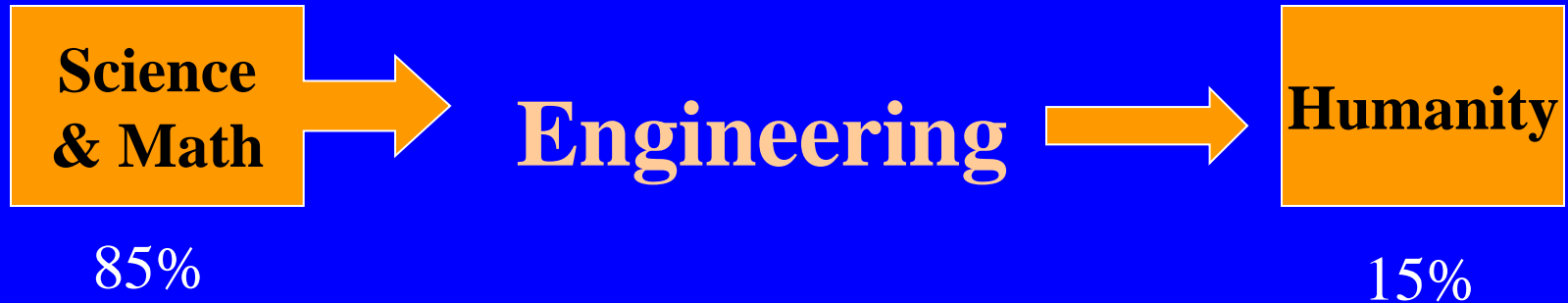
US Bachelor's degrees in engineering by year





Traditional Engineering

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“If it weren’ t for the people...always getting tangled up in the machinery...the world would be an engineer’ s paradise.”

It is about both

- How we teach
- What we teach

Traditional Education

Concept of equality

$$2 + 2 = 4$$

Satisfaction

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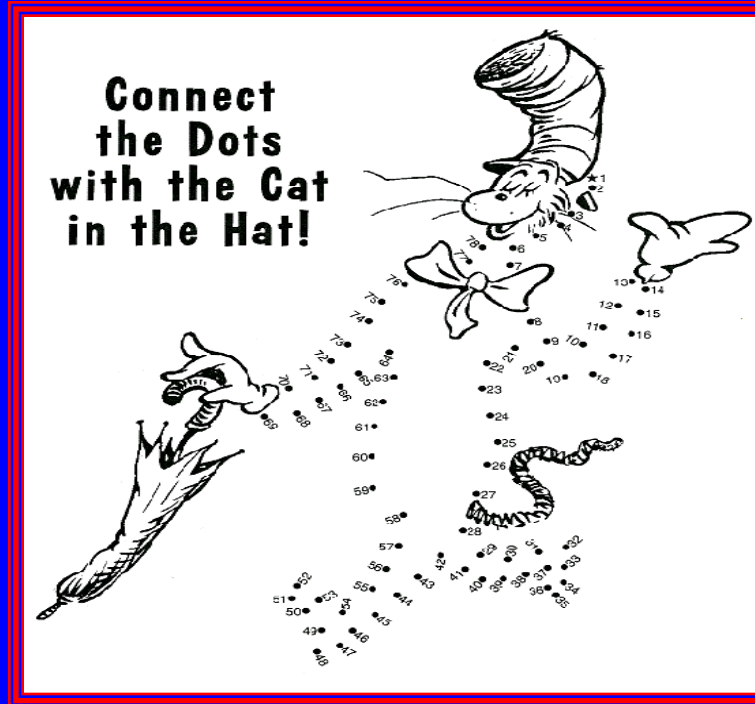
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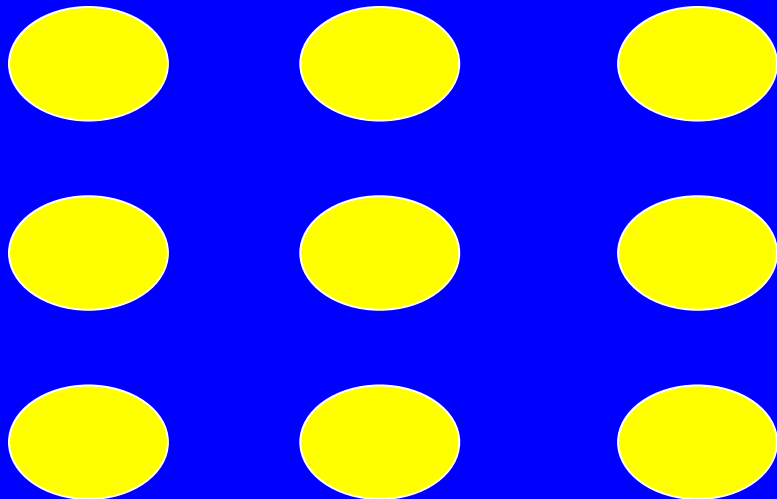
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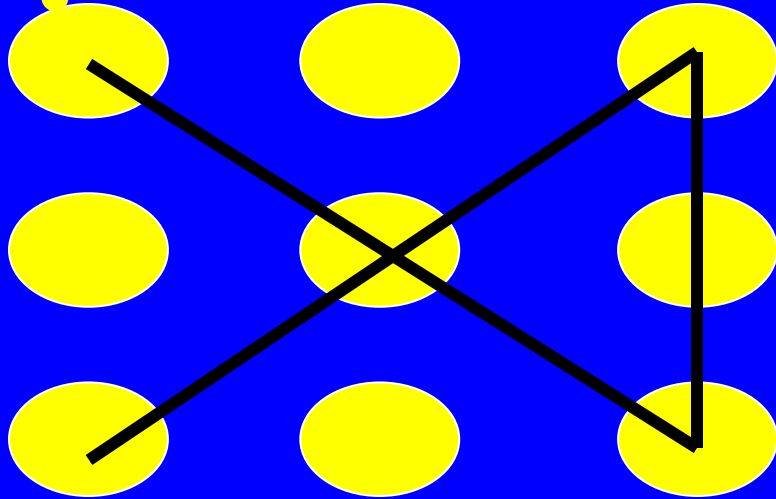
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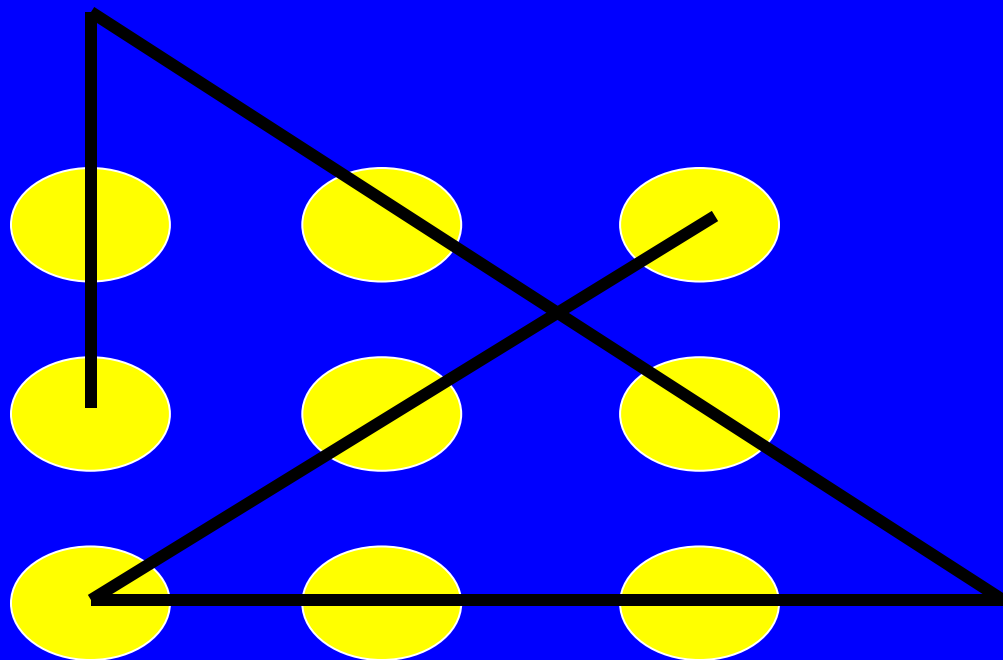
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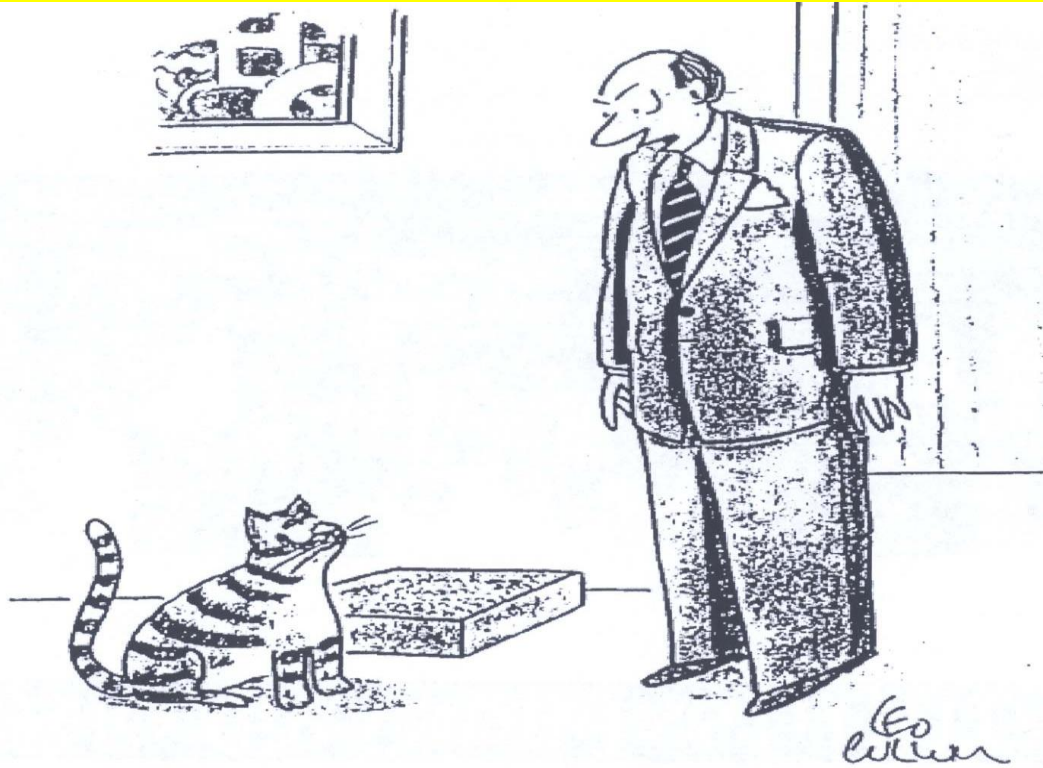


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The Bryant Park Project
Day to Day
Fresh Air
Morning Edition
News & Notes
Talk of the Nation
Tell Me More
Wait Wait...Don't Tell Me
Weekend Edition Saturday
Weekend Edition Sunday
Music Programs
All Songs Considered
From the Top
JazzSet
Marian McPartland's Piano Jazz

HEALTH & SCIENCE
Minty E. Coli and Other Bioengineering Feats
by Robert Krulwich
Listen Now [6 min 43 sec] + add to playlist



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MORE FROM 'RADIO LAB'
RADIO LAB, a production of WNYC, explores the blurring boundaries between science, philosophy and human experience.
» Radio Lab
» Radio Lab's Complete Show on (So-Called) Life

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Disease Deadly to Bats Spreads in Northeast U.S.
Heparin Victims' Relatives Urge Drug-Safety Reform
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MORE BY ROBERT KRULWICH
Young Indians Abroad Return to Help Better Country
Lucy's I laugh Enlivens the



“Anthropogenic Impact on
Global Geodynamics Due
to Reservoir Water
Impoundments”



Benjamin Fong Chao, NASA

Geophysical Research

Letters

Length of a day -8×10^{-6} sec
22 (24): 3529-3532, 1995



Austria

Germany

Japan

Netherlands

United States

Key Finding:

- Between 1/2 and 3/4 industrial inputs are returned to the environment as waste within *1 year!*

Technological Algorithm Paralysis

Today's problems come from yesterday's solutions.

Peter M. Senge, "The Fifth Discipline"

Corporate America Responding

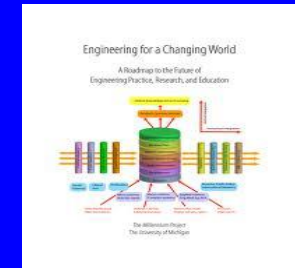
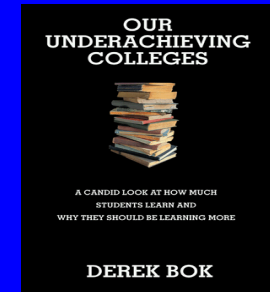
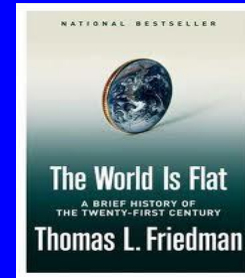
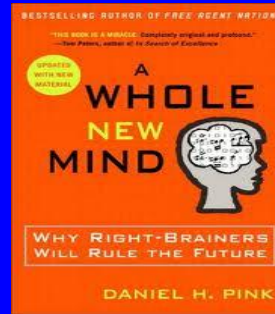
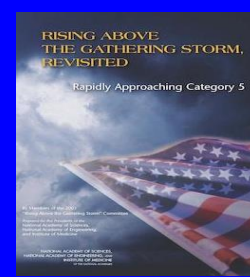
The center of gravity for innovation is shifting from solving narrow problems focused primarily on technology

to issues and opportunities

Technology is not Enough

IBM



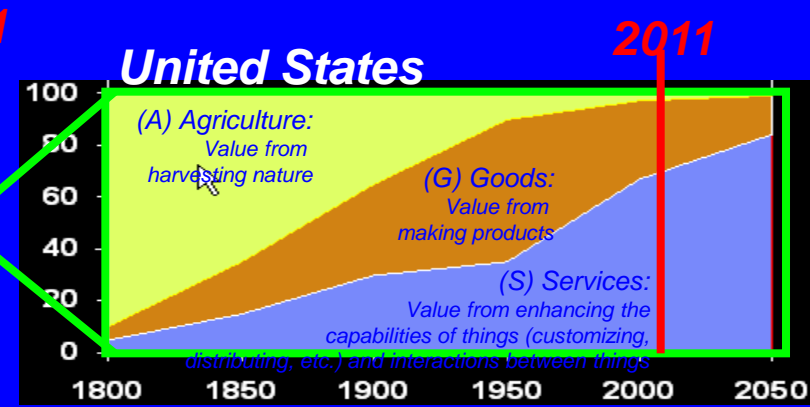


Shift to Services

Top Ten Nations by Labor Force Size (about 50% of world labor in just 10 nations)

A = Agriculture, G = Goods, S = Services

Nation	% ww Labor	% A	% G	% S	25 yr % delta S
China	21.0	50	15	35	191
India	17.0	60	17	23	28
U.S.	4.8	3	27	70	21
Indonesia	3.9	45	16	39	35
Brazil	3.0	23	24	53	20
Russia	2.5	12	23	65	38
Japan	2.4	5	25	70	40
Nigeria	2.2	70	10	20	30
Banglad.	2.2	63	11	26	30
Germany	1.4	3	33	64	44



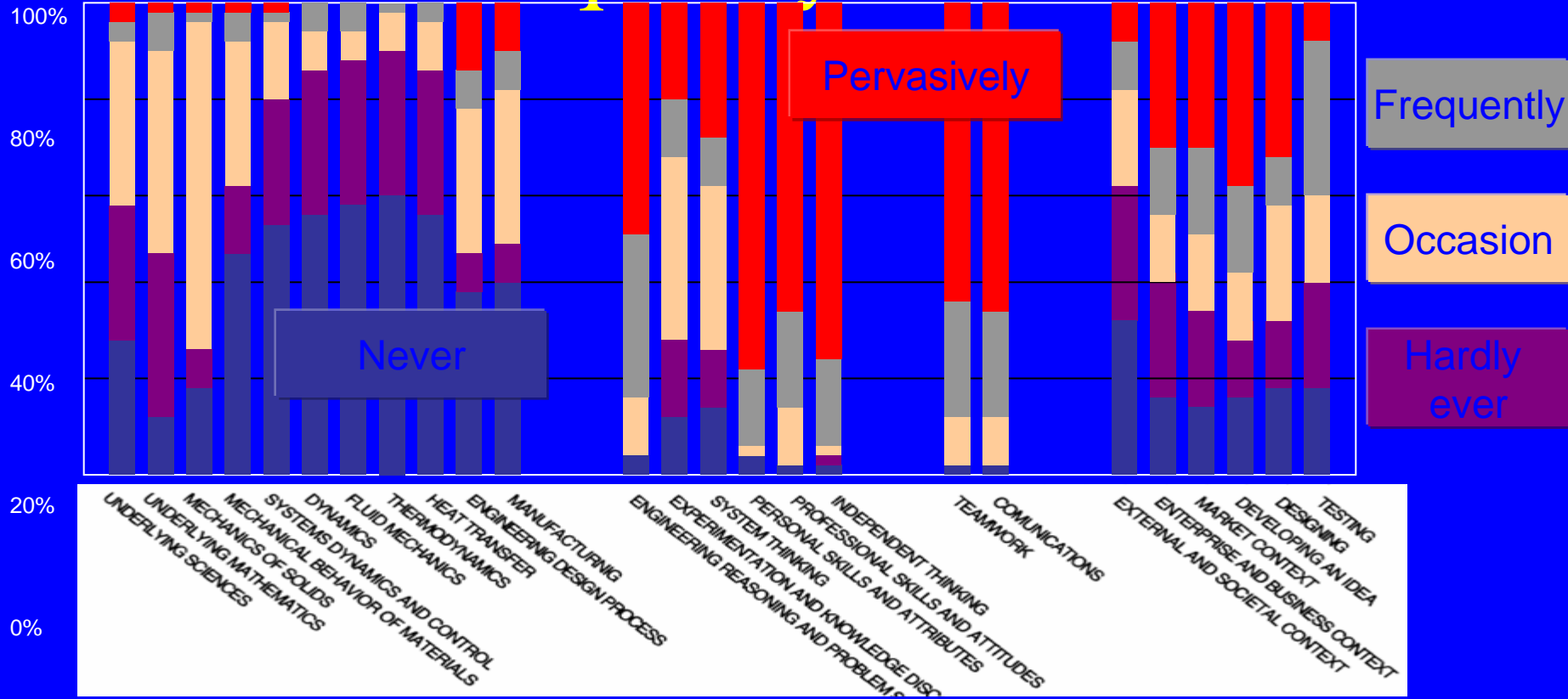
The largest labor force migration in human history is underway, driven by global communications, business and technology growth, urbanization and low cost labor.

>50% (S) services, >33% (S) services

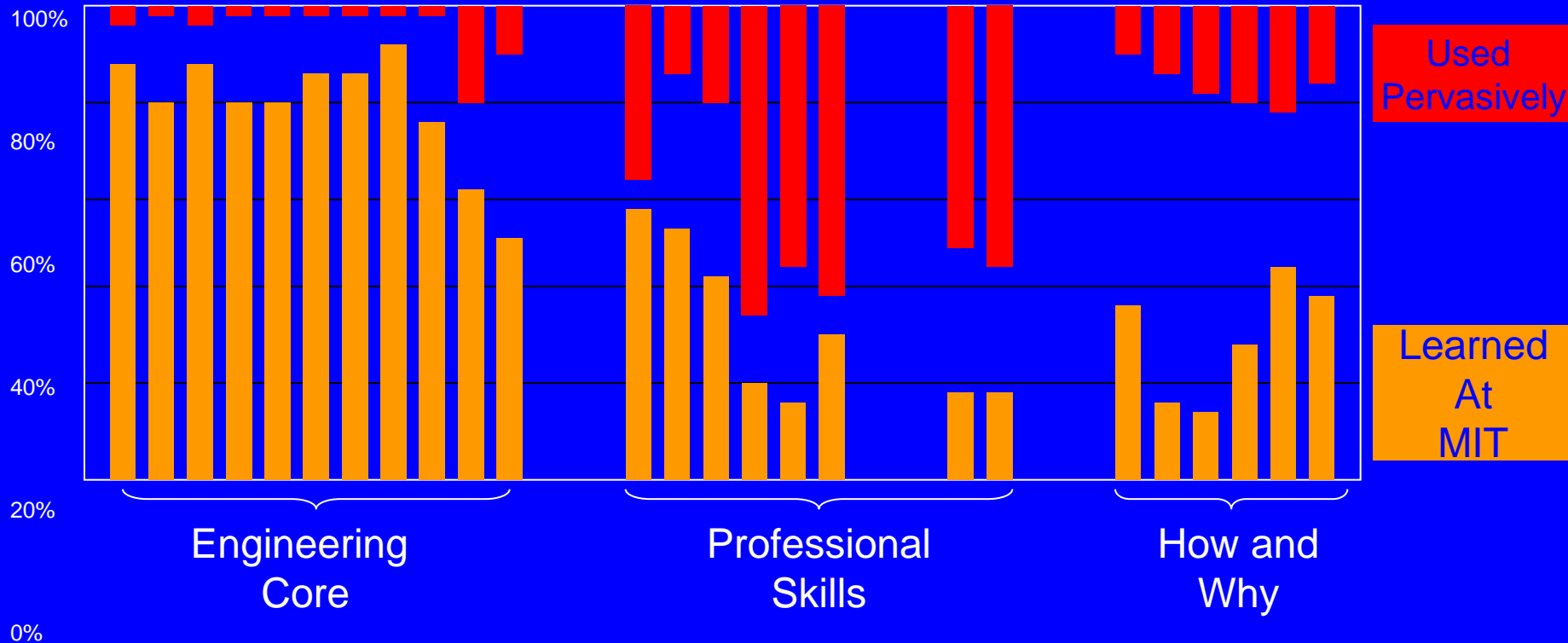
Courtesy of



Frequency of use



Where are the gaps?



SSME is an emerging



“Need I-shaped, T-shaped, π -shaped people...” – Stuart Feldman (Oct. 6, 2006)

Stockholm Traffic Problem



[http://www.seedforum.org/userfiles/Stockholm\(1\).jpg](http://www.seedforum.org/userfiles/Stockholm(1).jpg)

Another Bridge??



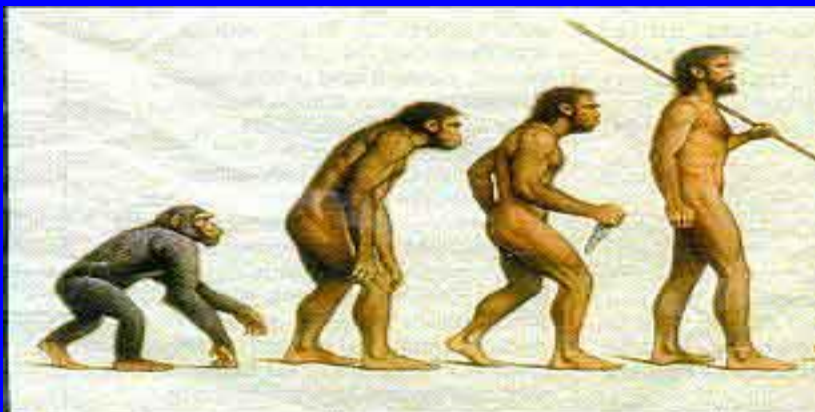
<http://bridgepros.com/projects/TacomaNarrows/TacomaNarrows.htm>

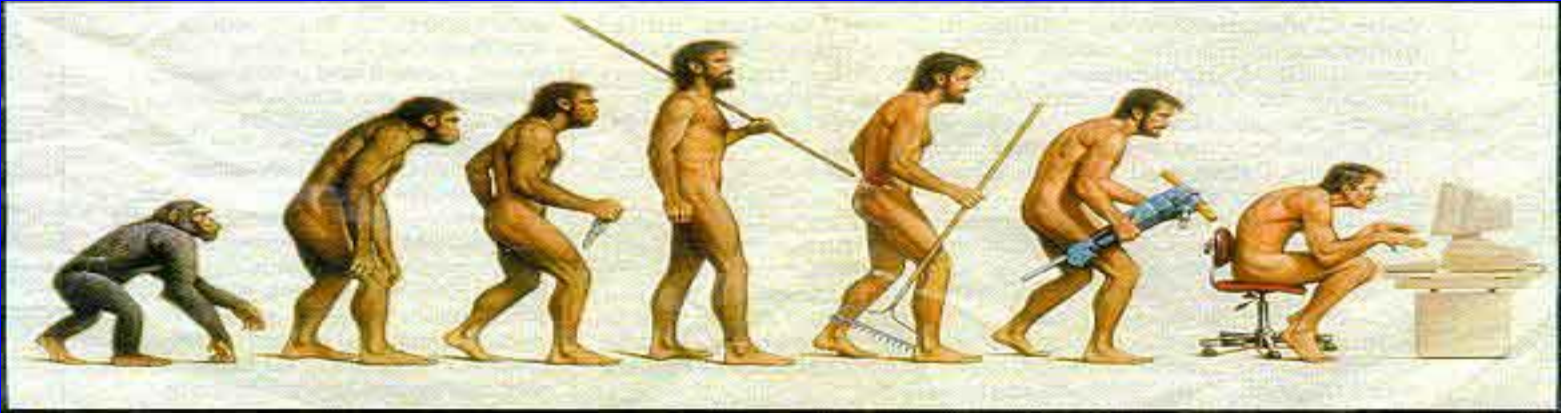
Holistic Solution

Results

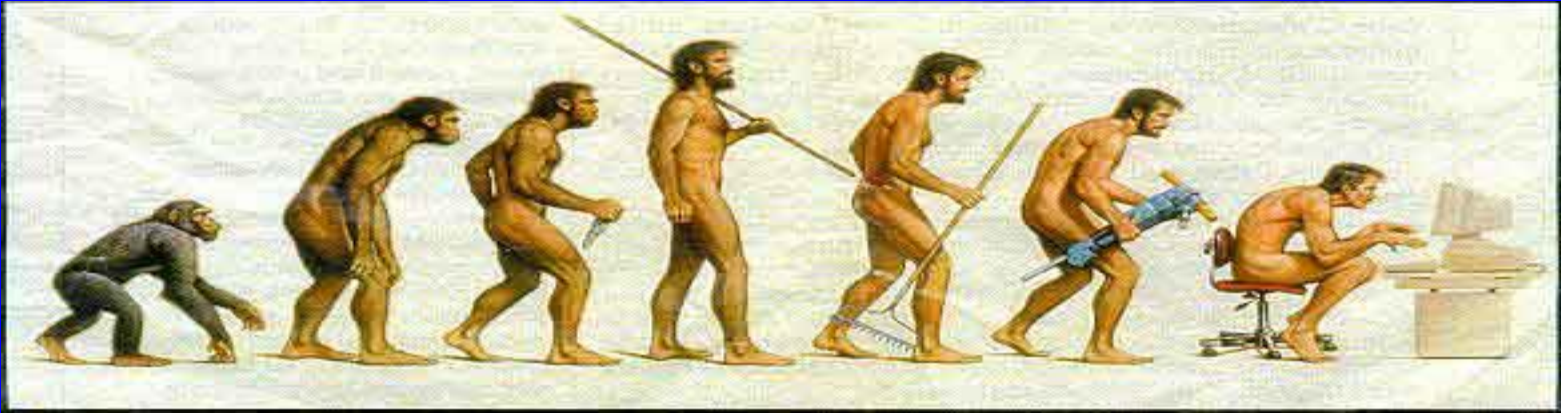


1. Traffic at cordon points reduced by 100,000 vehicle passages per day or 25%
2. Train and transit passengers increased by 40,000 per day
3. Congestion during peak hours dramatically reduced
4. No major re-routed traffic problem
5. Time tables for inner city bus lines have to be redesigned due





“The world we have created has problems that cannot be solved thinking the way we used to think when we created them”



“The future ain’ t what it used to be.”

Yogi Berra



GRAND CHALLENGES FOR ENGINEERING



Make solar energy
economical



Provide energy
from fusion



Develop carbon
sequestration
methods



Manage the
nitrogen cycle



Provide access to
clean water



Restore and
improve urban
infrastructure



Advance health
informatics



Engineer better
medicines



Reverse-engineer
the brain



Prevent nuclear
terror



Secure
cyberspace



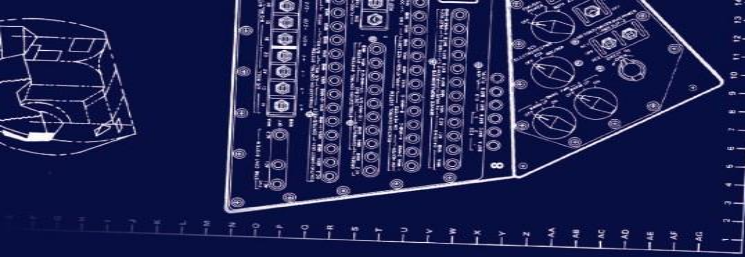
Enhance virtual
reality



Advance
personalized
learning



Engineer the tools
of scientific
discovery



Realizing the
power of
engineering
thought

Maybe next time...

**Thank God we are in the
hands of engineers!!**

