THE FUTURE OF EVERYTHING

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Summary
Since the beginning of the universe, technologies – and especially information technologies – have been changing at an exponential, rather than linear, rate. Five of these technologies (nanotechnology, biotechnology, information technology, cognitive technology, and social technology) actually feed on each other. A change in one causes even greater changes in the others. This leads many to believe that artificial general intelligence, where machines are as smart and then smarter than humans, will occur around the year 2040. In these next three decades, we must understand patterns, systems, and integrated management. As we approach the Singularity, we will become risk professionals.

Keywords
Future, technology, change, singularity, risk

ACCELERATING CHANGE

Technology changes are unrelenting and ever-increasing. Change changes – it is exponential rather than linear. Kurzweil and others have shown us that information technologies of all kinds have doubled in power (performance, capability, quantity, etc.) every year since the beginning of time. We see it in Moore’s Law of integrated circuitry, the Human Genome project, the cosmic clock of the universe, total number of Internet service providers, evolution of life forms, computer memory storage, etc. [1]

Two things make this exponential change difficult for us to recognize. First, a plot or graph of some feature over time will show very little change at first. All of a sudden, the change starts to take off like a rocket! However, if we plot the data in a logarithmic fashion, it becomes a straight line and much easier to understand. Second, our human brains have limited storage capacity. This restricts the amount of long-term memory available for use. Our brains must use recent memories when thinking about the future. [2] Those recent memories seem to be fairly constant, as we have flushed the big changes from our brain storage.

CONVERGING TECHNOLOGIES

Technologies affected by this accelerating change are also converging. Advancement in one will cause others to grow. Five of today’s preeminent technologies – nanotechnology, biotechnology, information technology, cognitive technology, and social technology – are all examples of this convergence.
Nanotechnology is the design and application of very small things. Examples include integrated circuit design, sun block, data projectors, and treatment of disease.

Biotechnology is the design and application of structures and systems using biologic principles. Examples include genetic software programming, automated pharmaceutical research, genome sequencing and assembly, and treatment of diseases.

Information technology is the managing and processing of large quantities of data. Examples include automated manufacturing, open-source programming, radio frequency identity tags, and the mind of Google.

Cognitive technology is the design and application of intelligence processes and thinking. Examples include unmanned military aircraft, automated trams, supercomputer brain simulation, and decision-making software.

Social technology is tapping the power and wisdom of crowds. Examples include blogs, social networks like Facebook, Twitter, Wikipedia, and virtual reality.

The interrelationships of these five technologies, one to the others, are called the NBICS Convergence. [3] An advance in one of these technologies will cause rapid changes in all of the others. They all feed on and support the others.

For example, blogs, wikis, and open research journals (social technology) allow researchers to discover and refine new analytical methods (cognitive technology). These new analytical methods require massive data sets from all over the world (information technology). Pattern analysis of the data (more cognitive technology) shows the potential for a piece of genetic code to convert cellulose into ethanol (biotechnology). Recent advances in lab-on-a-chip (nanotechnology) allow thousands of trials a day. More sharing (social technology) and analysis (information technology) show the chemical sequences. Using gene-splicing (biotechnology), a bacterium is manufactured (new life!) to convert agriculture waste into ethanol.

TECHNOLOGY SINGULARITY

The combination of exponential technology change and convergence leads many to believe that machines will rapidly become smarter than humans. Artificial general intelligence (AGI), where machines can reason and predict, will occur within about 30 years. [4] It certainly will not stop there. As machines become smarter and eventually exceed human intelligence, our relationship with this new sentient being also changes. The very nature of humanity is gradually changing. Machines and humans are – gradually – becoming one.

This is already occurring in our daily lives. It is so gradual that we hardly notice. (Recall the discussion above on our brain’s preference for short-term memory data.) We use Google and Wikipedia instead of the local book lending library. We depend on MRI and CAT scanners to detect disease. We keep contact data in our mobile phones. We use statistical analysis of crime data to predict future crimes. We use CRM, BPM, and data mining to increase business productivity. Intelligence analysis allows a hospital to predict a disease epidemic. Predictive software programs allow freight re-routing when storms close transportation corridors.
Just like stars imploding into a cosmological black-hole event horizon, humanity is approaching a social event horizon. Past assumptions about the world and our future are no longer valid when the machines think. This combination of ever-increasing technology change and artificial general intelligence is called the *Technology Singularity*. First used by Vernor Vinge in 1993 in a paper presented at a NASA symposium [5], it means we cannot know how our lives will change [6]. All of our previous knowledge and our conclusions become invalid.

**OUR FUTURE SKILLS**

As we approach this new man-machine environment, we must sharpen our professional skills in three areas: pattern recognition, systems thinking, and integrated management. As machine capabilities advance, the human will determine strategies and allow machines to implement those strategies.

**Pattern recognition and understanding**

We must become better at pattern recognition and understanding. This is the language of nature, where small variation, implemented many times like fractal geometry, can result in dramatic effects. [7] Research has shown our human brain to work by neocortical recognition of nerve stimulus patterns. [8] These stimulus patterns are processed to become recognition of our surroundings. This is a fairly low level of analysis. But at the high level of thought, we are still linear processors. If we ask them, our machines can detect these subtle patterns in government, industry, climate, and finance. But like recent market trading based on quantitative analysis, harm can occur if we are not careful. Patterns are all around us. We must act on them with knowledge and understanding.

**Systems thinking**

As professionals, we must understand systems and practice systems thinking. [9] We tend to focus on one event or one process at a time. It is easier. But the world works at a systems level. Processes are grouped and interconnected. System relationships give us unintended consequences. Distant change may ripple across organizations, time, space, and continents before other processes feel that effect. Individual and diverse processes all need to work in harmony to achieve the objectives of the whole. We all know that systems are complex, possessing both static and dynamic complexity. Using pattern analysis provided by the thinking machines, we begin to understand these complexities. Once we understand them, we can manage and use these complexities for our human betterment. Again, the machines help us to see these connections.

**Integrated management**

Over centuries of human civilization, we have developed special professions. Priests, carpenters, accountants, quality inspectors, safety specialists, and environmental remediation analyzers all work hard to develop a unique body of knowledge. Our professional value rests in our ability to use that special knowledge for the good of society and our employers. But the machines are quickly learning those specialties. They are doing it faster, and sometimes better, than we. Our future value lies in our ability to integrate management systems. Quality,
safety, security, finance, continuity, and environment all have a common foundation. They either stop bad things from happening or encourage good things to happen.

An illustration of this systems approach is the common safety triangle. We know that it is easier, faster, and cheaper to prevent or correct equipment breakdowns before they become near-miss events. These are quality tools. Attention to near-miss events will reduce or prevent job-loss occurrences. These are safety and environmental tools. Job losses (financial tools) are generally a precursor to accidental deaths.

![Figure 1: Safety Triangle](image)

This is the essence of risk management. We analyze where the potential risks might be. We evaluate the necessity to take action if the risk is unacceptable. We advise the organization on barriers, elimination, and remediation.

**CONCLUSION**

We are moving towards a common core of risk management professionals. With the help of smart machines, we shall analyze, evaluate, and act for the good of our planet, our society, our organizations, and our lives.

**REFERENCES**

The Future of Everything

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A story in three acts

Act 1: Change happens

Act 2: Major forces

Act 3: Effect on us
15 Billion years ago

Big Bang
10 Billion years ago

Stars Formed
5 Billion years ago

Early Earth
1 Billion years ago

Life Begins
1 Thousand years ago

Middle Ages
100 years ago

Industrial revolution
10 years ago

Dialup Internet
1 year ago
Let’s plot these

Big Bang
Stars Form
Life on Earth
Humans
Hastings
Industry
Dialup
I-Phone

Time to next event

Everything bunches up

No Scale
Logarithmic analysis

Time before present

Time to next event

Big Bang
Stars Form
Life on Earth
Humans
Battle of Hastings
Age of Industry
Dialup
I-Phone

1
10
100
1000
10000
100000
1E+06
1E+07
1E+08
1E+09
1E+10
1E+11
Moore’s Law

Calculations per second per $1,000
Mobile Telephones

Source: The Economist
Exponential Rate of Change

Applies to all technologies

- Cosmological clock of the universe
- Integrated circuit chips
- Evolution of life
- Forms of communication
- Patent applications
- DNA sequencing
- Computer memory storage
Law of Accelerating Returns

Information Technologies double in power (price, performance, capability, bandwidth, etc.) every year

Ray Kurzweil: Age of Spiritual Machines (1999)
Act 2

Major Forces
NBICS Convergence

- Nanotechnology
- Biotechnology
- Information technology
- Cognitive technology
- Social technology
Nano - Info

Chip design

Source: IBM
Nano - Bio

Biological assay
Nano - Bio

Sun block
Nano - Info

TI’s Digital Light Projector chip
Nano - Bio

Cancer treatment
Bio - Info

Genetic Programming

Genetic-programming.com
Bio - Info

Automated drug research 24/7

Solvay’s Automated Molecular Assembly Plant
Bio - Social

• DNA Explorer Kit
  (in-home analysis for $80)

• DNA analysis for genealogy research
Bio - Info

• Craig Venter has sequenced his own DNA and created synthetic bacteria (Mycoplasma laboratorium)
Open source promotes software quality
RFID tags eliminate manual inventory and speed transactions (100 kph toll booth!)
Mind of Google

• Google is identifying information spots (neurons) and linking them (nerve network) into a global intellect.
Mind of Google

- Mashups show where people congregate
- Touchgraph.com shows web page clusters
Virus is a nano-machine, with a hard protein shell to transfer RNA. Remove the inner stuff and use the hard shell to move small metal pieces. Shell structure allows for tight packing on a smooth surface. Panasonic funding Montana State U to develop data storage: 3 mos. of music on teabag-size disc.
Cognitive - Social

• By 2015, one-third of the US operational ground combat vehicles are to be unmanned.

Public Law 106-398 (2001)
Stanford University winning entry
Cognitive - Info

DARPA challenge in the streets (2007)
Cognitive Technology

• Marcos Guillen started Ccortex project in 2003 (supercomputer brain simulation)
Cognitive Technology

Jeff Hawkins has modeled the brain

First
must-read
book
Cognitive - Social

- Jeff Hawkins has released his brain software for open collaboration research. (2007)

Numenta.com
Social Technology

Power of the human community
Social-Bio-Info

- Internet is a multi-cellular organism, where single cells (servers) are networked to communicate and survive.

- Just the way our human nervous system operates.
Social - Info

Blogs (web logs) double every 256 days

Over 70 Million Weblogs Tracked.
Blogosphere growth remains strong with over 120k blogs being created every day.
Social Technology

• Open-access scientific journals increase information sharing

Public Library of Science
http://www.plos.org/
Social - Info

• MySpace has 110 million users.

• Facebook has 120 million users.
Social - Info

Second Life (January 2008)

Second Life is a 3D online digital world imagined and created by its residents.
Virtual Learning

- Google uses linking as a key parameter. Humans see value.
- Baby’s brain must be programmed through sensory inputs.
- Could we place a “dumb” entity on an Internet site and let thousands of users teach it?
- We already have – Wikipedia!
Conversations with computers
Not science fiction

• It’s happening right now – all around us
• Nano, bio, info, cognitive, social – they all connect (like a system) and support the others

What does it all mean?
NBICS: all converging
Artificial General Intelligence

Machines possess human intelligence

2040

Second must-read book
The Singularity

- *The Singularity* is the technological creation of smarter-than-human intelligence

- Vernor Vinge (1993)
- Predicted by 2040
- Why should it stop?
OMG!
Gradual Evolution

It’s not like falling over the edge!
It’s already happening!

• Police used crime statistical analysis to correctly predict the time and location of a robbery – before it occurred.

It’s already happening!

• Benford’s Law of Abnormalities is being used by securities analysts to detect fraud in financial reports.

Source: Intelligent Enterprise, Dec 4, 2004
It’s already happening!

• John Deere is using software modeling to forecast parts inventory to dealers.

• Moving from push to pull.
It’s already happening!

• Business intelligence applications allow hospitals to *predict* epidemic outbreak patterns across a region, and prepare for bio-terrorism responses.
It’s already happening!

• Predictive analytics software allows Wal-Mart to swiftly redirect trucks after a hurricane.

• Airlines use computers to redirect crews and aircraft when weather closes the airport.
It’s already happening!

- My examples are friendly AI
- They don’t look like us or act like us
- They serve us
- They improve our quality of life
Becoming a new species
Wow
Act Three

• So what does this mean to our profession?
4th Era of Management

1. Control (product)
2. Assurance (process)
3. Management (system)
4. Integration (whole)

CAMI
Quality Control

- From the age of industrialization to Korean Conflict
- The roots of ASQ(c) and EOQ
- Emphasis on product and inspection

about 50 years
Quality Assurance

• Started with military and nuclear programs in the 1960’s and 1970’s
• Required by greater complexities and technology changes
• Captured by Say What You Do and Do What You Say
• Doesn’t reject QC, but adds to it
• Peaked with ISO 9001:1994

about 25 years
Quality Management

• Focus on procedures (QA) was not enough as we entered the Internet Age
• We need to understand and manage all the resources of the organization
• Started with Baldrige, ISO 9001:2000, and EFQM
• Adds systems to process (QA) and product (QC)

about 15 years
Quality Integration

- Quality is combining with environment, safety, security, finance, risk, etc.
- Holistic thinking
- 7 year duration?

Our journey into this era …
Future skills

• Pattern recognition
• Systems thinking
• Integrated approaches
Pattern recognition – not yet

- Most software and computer processors are still designed using von Neumann architecture.
- Our professions use series logic (PDCA).

Planning → Performing → Improving → Measuring
Pattern recognition

• To survive in the future, we must move from
  – *place* (geometry of the ancients)
  – to *pace* (algebra of Newton)
  – to *pattern* (design of biology)

From James Bailey: *After Thought*
Systems thinking

Fifth Discipline by Peter Senge (1990)

Third, and final, must-read book
Systems are complex
Integrated approaches

Safety

Quality

Environment

Security

Disaster

Finance

Social Responsibility
It’s all about risk!

• Unhappy customers
• Pollution of the planet
• Harm to living creatures
• Damage to property
• Bad guys
• Loss of revenue
Risks are hard to spot

• Software programs that monitor and record key strokes compromise finance

• Networked CAT or MRI machines are targets for viruses and worms, causing compromised medical data

• How will climate change affect us?
Holistic thinking

Using systems, culture and technology to:

Protect the whole
Whew!

A recap please
Point One

The Law of Accelerating Returns
Point Two

Artificial General Intelligence - 2040
Point Three

Integrated Systems – Our Future
Work with the machines

• We will use our 5,000 years of civilization to define the way.
• Machines will use their superior abilities to achieve those strategies.
Enjoy the ride!
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