



# The Age of Spiritual Machines

## When Computers Exceed Human Intelligence



Chaos in Manufacturing  
Santa Fe  
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## The Speed of Time



Einstein defined time relativity - in Physics

Some things - living species - seem to experience time on a different scale.

In the Universe - Time (between salient events) is slowing down

In Evolution - Time (between salient events) is speeding up.

The nature of exponential growth - events develop very slowly for long periods of time - but at the knee of the curve, events erupt at a furious pace.

Exponential speed-up is occurring as we enter the 21st century.

# Laws of Entropy - Physical & Spiritual

The Law of Increasing Entropy (Disorder)

Evolutionary processes

- increasing order
- emergence of Life and Intelligence
- Does not violate 2nd Law - NOT a closed system

The Pinto Postulate : “**Law of Increasing Spiritual Entropy**”

- Extropy
- offsetting “positive order”

<http://www.extropy.com/>

## Evolution - from Chemistry to Biology



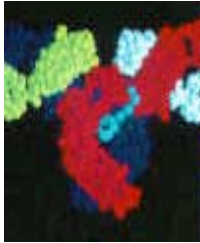
2 billion years after Earth was formed - life began  
Patterns of matter and energy that could perpetuate themselves, did

With Time, the patterns became more complicated  
- from Chemistry to Biology.

A key element of an evolutionary process is a “written record”  
- otherwise it would be doomed to repeat.

DNA - the digital computer designed by Evolution  
to record its handiwork.

# Evolution - Time Speeding Up



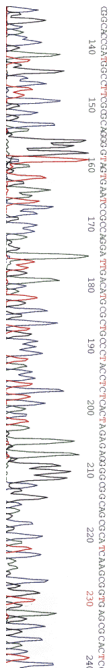
Evolution took billions of years to design the first primitive cells - and then salient events took only hundreds of millions of years - a distinct quickening of the pace.

Some calamity finished off the dinosaurs about 65 million years ago, and mammals inherited the Earth. Emergence of Primates - progress measured in mere tens of millions of years. Humanoids emerged 15 millions years ago, distinguished by walking on their hind legs - now we are down to just millions of years.

Homo Sapiens emerged about half-million years ago - not very different from other advanced primates - DNA is 98.6% the same as the gorilla, and 97.8% the same as orangutans.

Evolution since that time focuses on a human-sponsored variant of evolution - **Technology**.

## Technology Evolution by Other Means



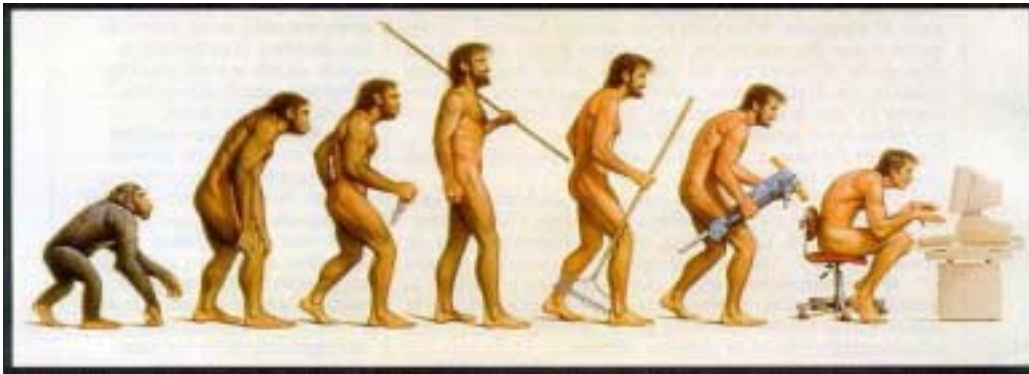
Homo Sapiens was distinguished by their *invention* of technology. Technology goes beyond the making and use of tools - it involves a record of tool making and a progression in the sophistication - requires invention. It is itself a continuation of Evolution.

The “genetic code” of the evolutionary process of Technology is the records maintained by the tool-making species. In early life, it was chemical composition and DNA. With tools it is written language and now computer databases.

There were multiple subspecies of Homo Sapiens - several subspecies initiated the creation of technology - the technologically more advanced groups became dominant.

Evolution - Selection through Survival.

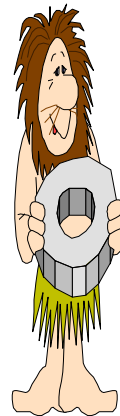
# Technology - Extension of Evolution



## Technology Accelerated Evolution

Technology, like Evolution that spawned it - is inherently an accelerating process.

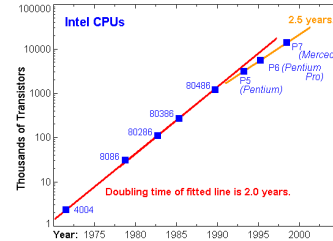
- ◆ Mechanical (Tools, Machines)
- ◆ Electromechanical (Relays)
- ◆ Electronic (Vacuum Tubes)
- ◆ Transistors (Solid-state)
- ◆ Integrated Circuits - leading to Moore's Law



# The Emergence of Moore's Law

Exponential growth of computing dates back to the start of the twentieth century

Gordon Moore (Intel) noted (1965) that the surface area of a transistor was being reduced 50% every 12 months. The 1975 update was 24 months.

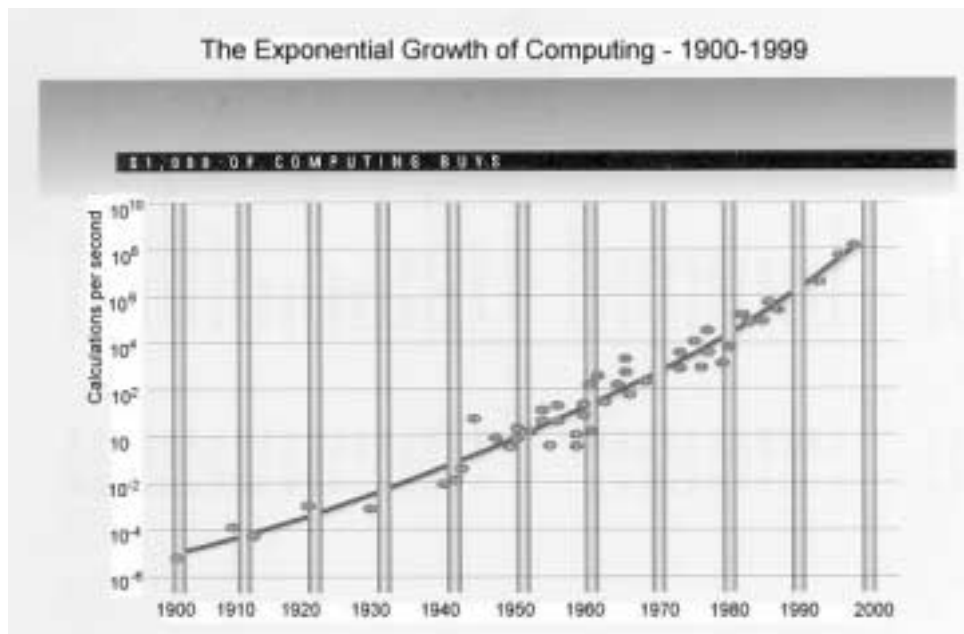


Cost of an IC is fairly constant. Twice as much, running at twice the speed for the same price. For many things, that is quadrupling of performance. Driving the acceleration of computing for 40 years.

Moore himself predicts end by 2017 (total of 60 years) - beyond that, the paradigm will “break”. Transistors will be only a few atoms thick. What then?

<http://www.intel.com/intel/museum/25anniv/Hof/moore.htm>

## \$ 1000 Computers - 1900-1999



# The Law of Accelerating Returns

***“As order increases, so Time speeds up.”***

Where does this leave Moore’s Law?

Still dead by 2020 - but another computational technology will pick up where Moore’s Law left off, without missing a beat!

Most exponential trends hit a wall - not this one!

The Inventor of Chess and the Emperor of China

- at the start of the next century, we are in the second half of the chess board.

# The Intelligence of Evolution

Consider the process that created us - God? Evolution?

Software recorded as digital data in the chemical structure of an ingenious molecule called **deoxyribonucleic acid** - DNA - the master read-only memory that controls the vast machinery of life. Remarkably complex and amazingly simple - Only four basic pairs provide the data storage for the complexity of all the millions of life-forms on earth, from primitive bacteria to human beings.

The ribosomes - little recorder modules - read the code and build proteins from only 20 amino acids. Everything is programmed from this efficient code!

This is “*nano-engineering*” - the machinery of life takes place on the atomic level. This is our understanding of the hardware.

# Evolution

## - Inefficient Programmer

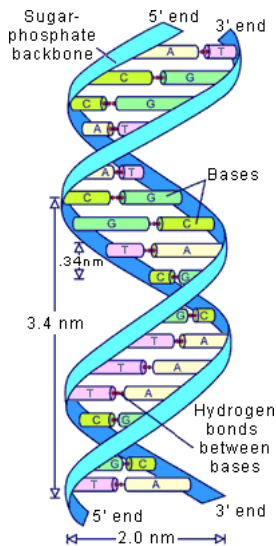
Evolution is a very inefficient programmer - most of the code “does not compute”. Most of the sequences do not produce proteins. 97% of the code is useless. This means the active part of the code is only about 23 megabytes - less than Microsoft Word.

Only object code - no source code, no programming manual, no help files, no user manual. Evolution seems to introduce changes only at random - changes are evaluated over time by survival, and ability to reproduce. Survival appears to be a crude technique - focussing on a few features at a time.

Intricate designs like the eye cannot have been designed through incremental refinement - it must have been done “all at once”.

Evolution cannot easily perform complete re-designs. It is stuck - in time.

## The Human Genome Project



International research program with the goal of gathering a resource of genome maps and DNA sequence information that will provide detailed information about the structure, organization and characteristics of the DNA of humans and other animals.

The project began in the mid-80's and is expected to be complete by around 2003 (18-20 years)

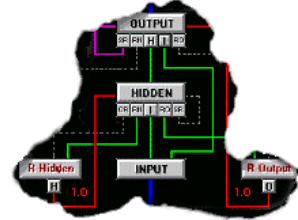
<http://www.mcet.edu/genome/>

<http://www.nhgri.nih.gov/>

# The IQ Of Evolution

Evolution has produced millions of designs.  
Deficiency - it is very slow!

Most IQ tests are timed.  
The IQ of Evolution is infinitesimally above zero  
- only a bit smarter than random behaviors.



The reason that our human-sponsored evolution is “smarter” is that we speed up time.

**The Question** : Can Human intelligence create an intelligence more intelligent than itself?

# Human or Machine?



Is a human with mechanical implants a machine?  
Is a machine with human extensions a human?

How do you “experience” color?  
Are animals more human? Or machine?  
When does a fetus achieve consciousness?

Consciousness is a Being Reflecting on Itself  
- I think therefore I am.

Different Schools of Thought

- **“Consciousness is different kind of stuff”**
- **“We can’t understand”**
- **“Thinking is as Thinking does”**

# Deep Blue vs Kasparov



“As Deep Blue goes deeper and deeper, it displays elements of strategic understanding. Somewhere out there, mere tactics are translating into strategy. This is the closest thing I’ve seen to computer intelligence. It’s a weird form of intelligence. But, you can feel it. You can smell it!”

*Frederick Friedel, assistant to Gary Kasparov, commenting on the computer that beat his boss.*

## Intelligence The Recursive Formula

Pruning the possibilities, stopping the recursive growth of the tree of possibilities.

Humans advancing by almost zero - computer recursive depth capabilities doubling each year. You could predict when the computer would beat a human at Chess (97/98).

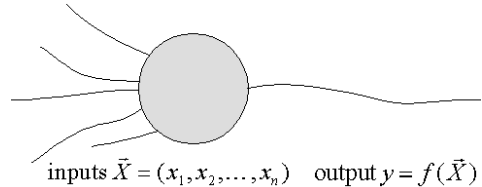
Recursion is suited only to problems with well defined rules. Games, music, poetry (especially rhymes). Kurzweil's Cybernetic Poet uses a recursive approach - with limited success.

# Intelligence - Neural Nets

Attempt to emulate the computing structure of neurons in the human brain:

- a/ Set of inputs that represent the problem to be solved;
- b/ Inputs randomly wired to a layer of simulated neurons;
- c/ Each connection has a strength (initially set at random);

Starts out ignorant, and “learns”.  
Connections that “help” the right answer  
are made stronger, connections that  
“hurt” are made weaker.



Neural nets are good at pattern recognition types of problems.

Elimination of Information - the key to intelligence - reducing thousands of inputs to an intelligent output, and discarding the rest.

<http://www.calresco.org/neural.htm>

# Intelligence - Evolutionary (Genetic) Algorithms

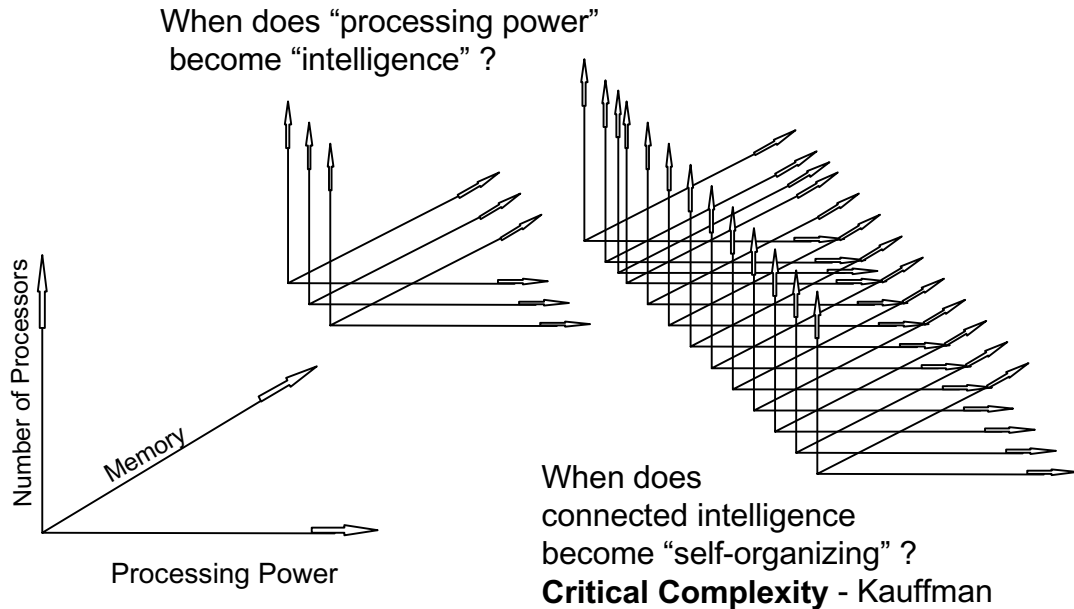
Originated by John Holland - early 70's.

Solutions are not programmed - they emerge through an iterative process of simulated competition and improvement. Smart but slow - retains the discernment of Evolution - but useful if speeded up a million fold.

Genetic Algorithms are used to solve otherwise intractable business problems. Example - stock-market : Generate a million rules for making investment decisions. Kill off the ones that are unsuccessful. You're left with the ones that are successful. Several successful investment funds are making decisions this way. \$ 95billion being invested today.

<http://www.calresco.org/genetic.htm>

# Extending Intelligence



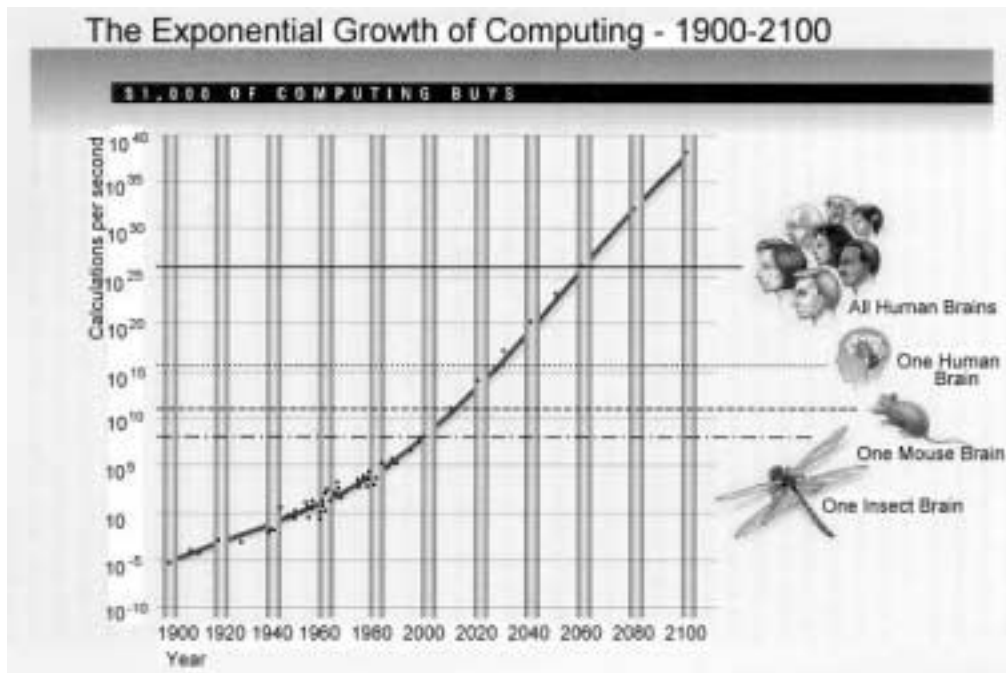
## Achieving the Hardware Capacity of the Human Brain

Moore's Law - when it dies in 2020, new forms of circuitry will continue.

Human brain - 100 billion neurons - estimated 1,000 connections between each neuron and its neighbors, 100 trillion connections, each capable of simultaneous calculation. However - only 200 calculations per second. For problems requiring massive parallelism (like pattern recognition) this is great. But, for extensive sequential thinking, this is mediocre.

100 trillion connections - each 200 calcs per sec - 20 million billion calcs/sec. So, when will we see equivalent speed ?

# Growth of Computing 1900-2100



## Computing Substrates in the 21st Century



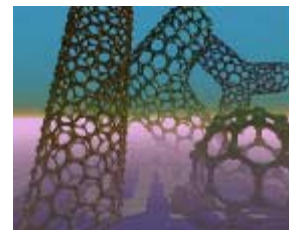
Standard IC methodology will get close to human brain by 2020. Including 3-dimensional ICs - **Cubic Memory, Dense-Pac, Staktek.**

Computing with Light - **Quanta Image, Photonics, Mytec** - optical computing - calculations performed in parallel by optical elements. Massive parallelism makes it good for things like pattern recognition.



**Molecular Computing** - Harnessing the DNA molecule as a practical computing device.

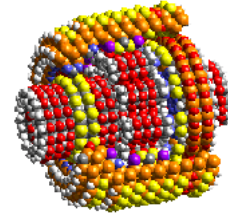
**Nanotubes** - elongated carbon molecules that look like tubes. Become conductors or semi-conductors dependent on the shape. Only 1 atom thick. Can be assembled in 3-dimensional arrays. Far denser than the human brain.



**Quantum Computers** - Qu-bits - each bit is 0 and 1 at the same time, with a probability.

# Nano-Engineering

**K. Eric Drexler** - founding father of “**nano-technology**”,  
Use individual atoms & molecules to build machines.  
Institute for Molecular Manufacturing: <http://www.imm.org/>



If you can engineer DNA on a molecular level, why not build machines out of atoms, program them to build more machines, and so on - until you have millions of infinitesimal “nanobots” - endlessly restocking the food supply, or swarming through the bloodstream eradicating disease, or building skyscrapers from industrial waste? If “nanotech” is viable, it promises a gleaming future of virtually limitless wealth and endlessly renewable resources.

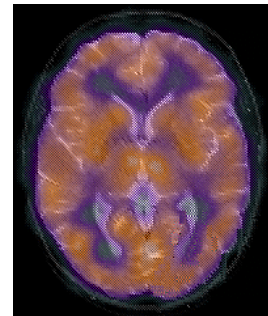
*Engines of Creation - Drexler (1986)*

*Nanosystems: Molecular Machinery, Manufacturing and Computation  
Wiley Interscience (1992)*

## Reverse Engineering the Human Brain

We can do a detailed brain scan  
- to understand it.  
Within a region, a brain is highly repetitive  
- so we need to only scan a portion.

Downloading your mind to a personal computer.  
What will we find when we really do this?

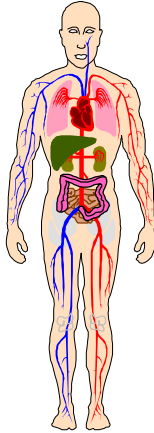


In the 21st century there will be growing trend to do this.

The age of neural implants has already started.

What is mortality? If you are “backed up” how can you be “dead” ?

# 21st Century Bodies



Body and Brain will be enhanced together.

Enhancing bodies cell by cell  
Nano technology - building atom by atom

Building replicas - the Blob

Morphing in the real world - self-replicating at the atom level.  
What happens if we fail to halt the self-replication?

Hey, why do we need bodies? Virtual bodies?  
What is **Real** Virtual Reality?

The **Sensual** Machine

## The Rise of Technofascism



"We stand on the verge of being able to change the human race"

- *Wired Magazine*, January '98

"Silicon Valley is in supernova - eclipsing even Hollywood, New York and Washington, D.C."

- *Upside Magazine* - August '98

Today, the demarcation between the worlds of the bright and the merely average is as rigid and impenetrable as the "white" and "colored" sections of a Memphis, TN. movie theater were in 1935. The only difference is that in 1935, blacks at least had the hope of one day achieving equality. In an age when every organization's catchphrase is "smarter, faster, better" who's going to stand up for the millions - indeed, by definition, the majority - with average intelligence?

- *Michael Malone* - *Upside* - August '98

<http://www.upside.com/teaxis/mvm/story?id=35927f000>

# The Spiritual Human



Once neural implants are common, we'll be able to stimulate a wide range of "feelings" There are already neurological triggers for such things as humor.

Understanding the neurological correlation of "spiritual experiences" - translates to the computational processes that give rise to spiritual

The God spot - UCSD scientists have found a tiny locus of nerve cells in the front lobe that appears to be activated during religious experiences.

# The Spiritual Machine



Machines derived from human thinking and surpassing humans in their capacity for experience will indeed claim to be spiritual.

21st century machines will go to real or virtual houses of worship, meditation, praying and transcending - to connect with their spiritual dimension.

# Machine or Spirit?

We are NOT human beings trying to  
be spiritual - we are spiritual beings  
trying to be human

- *Jacquelyn Small*

Humanity looks to me like a  
magnificent beginning  
- but not the final word.

- *Freeman Dyson*

Body & Soul are twins - God only  
knows which is which.....

- *Charles Swinburne*

## Web Links

Good links to all topics : <http://www.penguinputnam.com/kurzweil/>  
Extropy - Positive Entropy : <http://www.extropy.com/>  
Moore's Law : <http://www.intel.com/intel/museum/25anniv/Hof/moore.htm>  
MIT Artificial Intelligence Lab : <http://www.ai.mit.edu/>  
Artificial Life (Santa Fe) : <http://alife.santafe.edu/>  
The Human Genome Project : <http://www.nhgri.nih.gov/HGP/>  
Ray Kurzweil's Cybernetic Poet : <http://www.kurzweiltech.com/>  
Computer Art : <http://www.artworks.co.uk/welcome.htm>  
Kurzweil Cybernetic Poet : [www.kurzweiltech.com](http://www.kurzweiltech.com)  
Paintings by Aaron : <http://www.scinetphotos.com/aaron.html>  
Autonomous Agents : <http://www.cs.bham.ac.uk/~amw/agents/links/index.html>  
DNA Computers : [http://www.mitre.org/research/nanotech/hapgood\\_on\\_dna.html](http://www.mitre.org/research/nanotech/hapgood_on_dna.html)  
Genetic Algorithm Archive : <http://www.aic.nrl.navy.mil/galist/>  
NanoTechnology - Eric Drexler : <http://www.foresight.org/EOC/index.html>  
[Molecular Manufacturing](http://www.imm.org/) : <http://www.imm.org/>  
Neural Networks : <http://www.calsci.com/>