Next gen perception and cognition: augmenting perception and enhancing cognition through mobile technologies

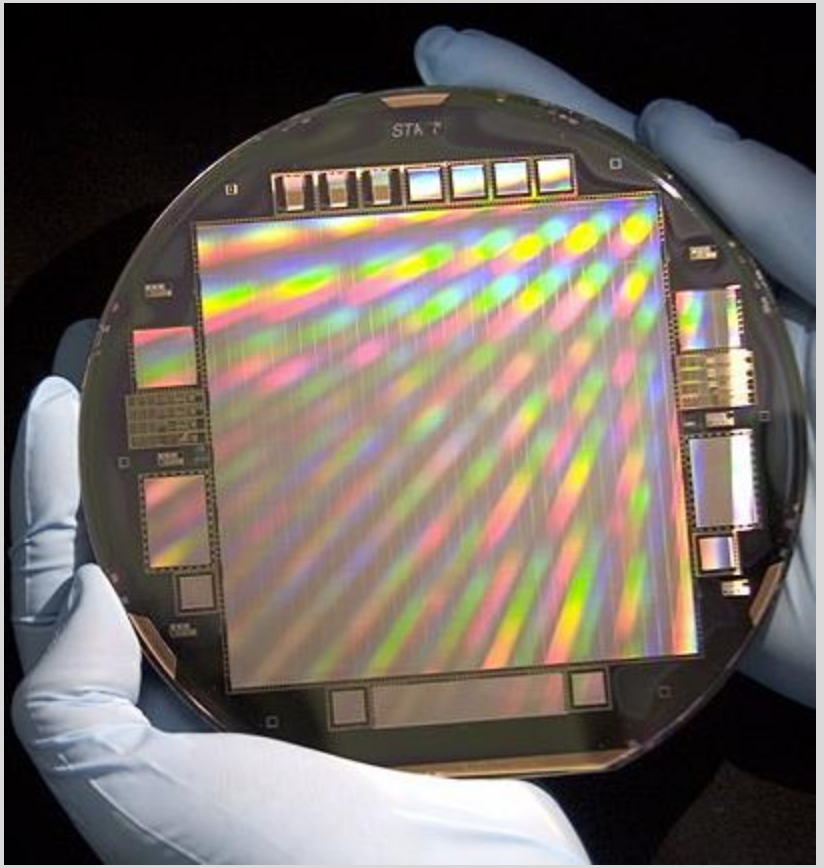
Sergio Goma - Qualcomm

Mobile technologies are ubiquitous…



The Pyramid and the 112mpix CCD





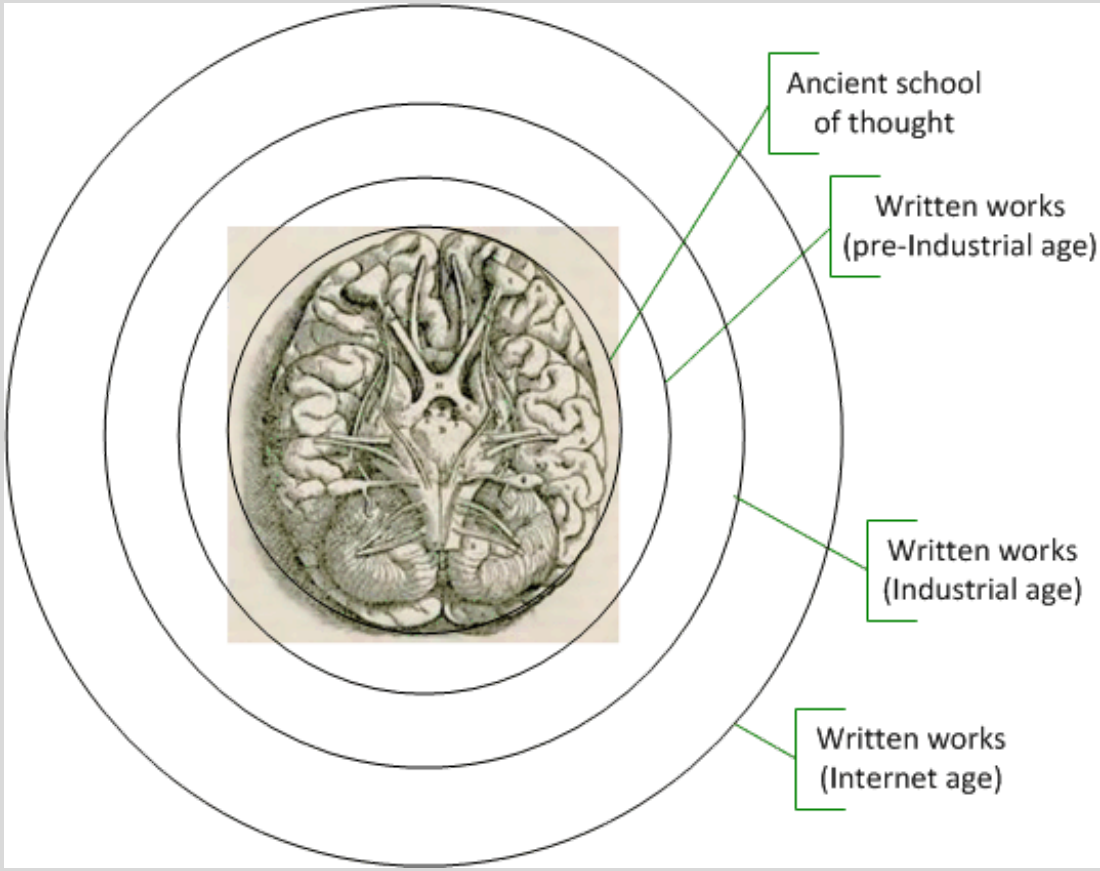
Each technology grows to reach a saturation, then morphs in the next.

Today, not only the ability to build requires technology augmentation, but also ability to understand all details of a complex design requires technology augmentation.

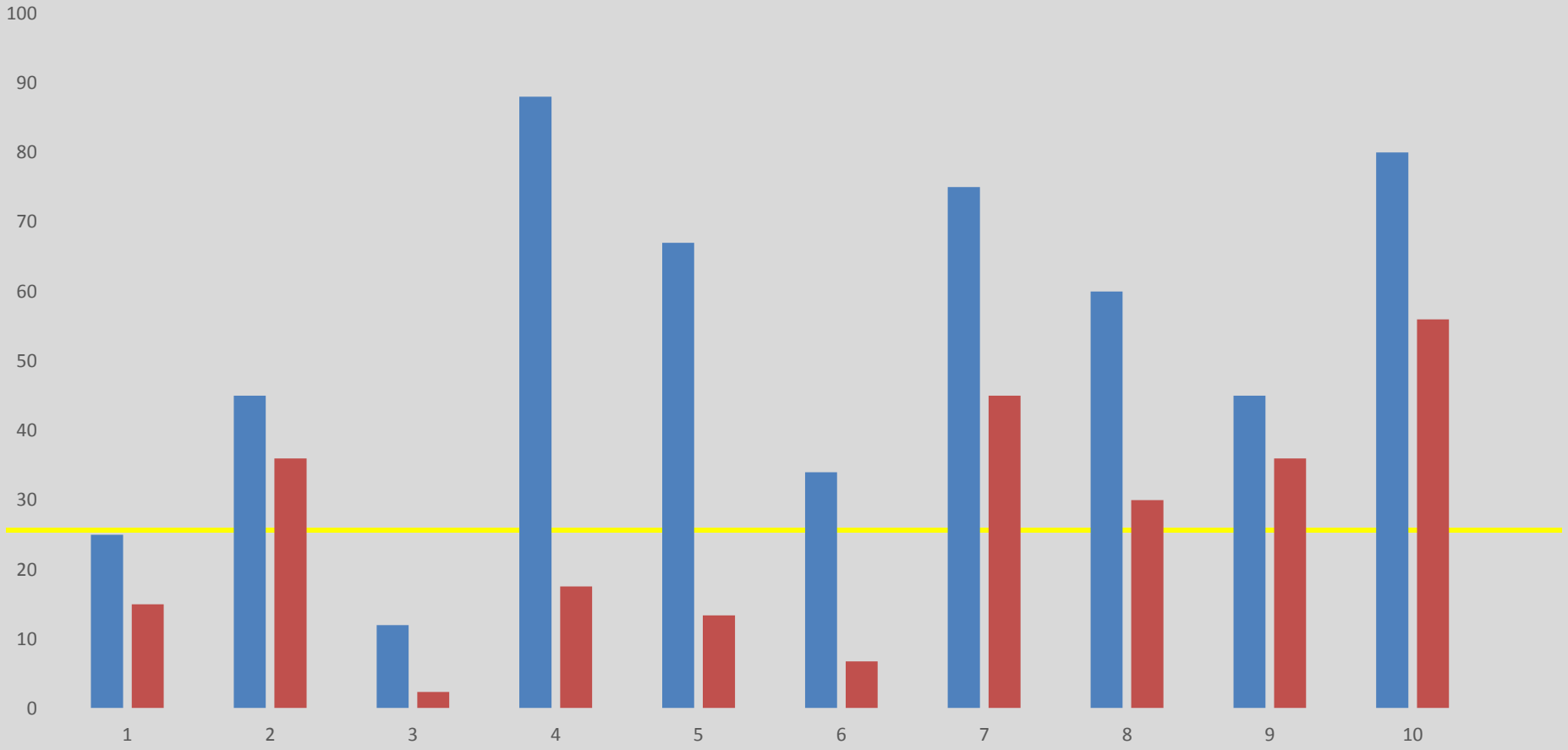
Periodical saturation in passing knowledge

- An essential step in our evolution was increasing the knowledge past our natural limits: preserving solutions to solved problems and passing them to other individuals are essential part of that.

- Each method of passing knowledge, at a time, seemed to have reached a saturation.

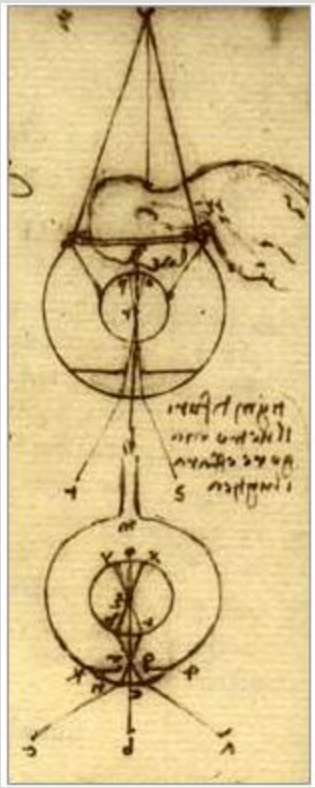


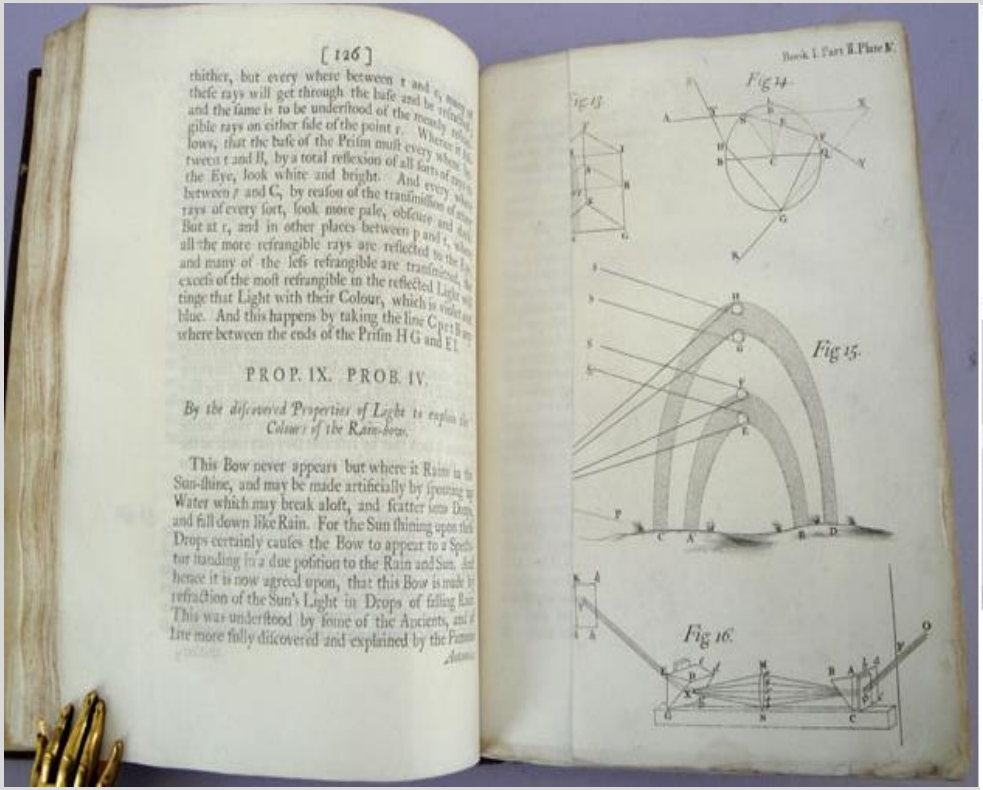
Problem complexity vs. individual problem solving and communication of results



Communication of results is limited by the particular method of that time period.

Hierarchical problem solving – standing on the shoulders of giants





[126]

thither, but every where between r and s, many of these rays will get through the hafe and be refracted: and the fame is to be underftood of the reamoly refrangible rays on either fide of the point r. Whereas it follows, that the bafe of the Prifm muft every where between r and B, by a total reflexion of all forts of rays: the Eye, look white and bright. And every where between p and C, by reafon of the tranfmiffion of all rays of every fort, look more pale, obfcure, and dull. But at r, and in other places between p and r, where all the more refrangible rays are reflected to the Eye, and many of the leaft refrangible are tranfmitted, the excefs of the moft refrangible in the reflected Light will tinge that Light with their Colour, which is violet and blue. And this happens by taking the line GpeCB anywhere between the ends of the Prifm HG and EI.

PROP. IX. PROB. IV.

By the difcovered Properties of Light to explain the Colours of the Rain-bow.

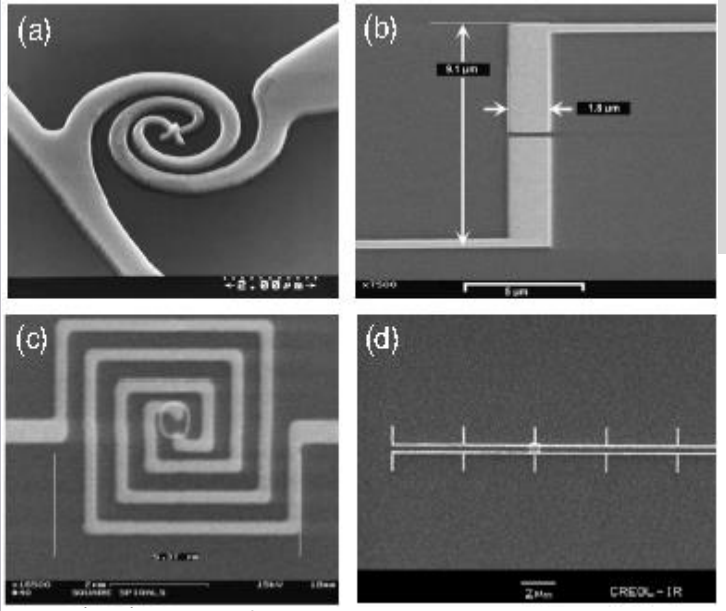
This Bow never appears but where it Rains and the Sun fhine, and may be made artificially by fprinting Water which may break aloft, and fcatter into Drops and fall down like Rain. For the Sun fhining upon thefe Drops certainly caufes the Bow to appear to a Spectator ftanding in a due pofition to the Rain and Sun. And hence it is now agreed upon, that this Bow is made by refraction of the Sun's Light in Drops of falling Rain. This was underftood by fome of the Ancients, and of late more fully difcovered and explained by the Famous

Book I. Part II. Plate V.

Fig 14.

Fig 15.

Fig 16.



220. M. I. Stockman, S. V. Faleev, and D. J. Bergman, "Coherently controlled femtosecond energy localization on nanoscale," Appl. Phys. B **74**, S63–S67 (2002).

221. M. I. Stockman, "Nanofocusing of optical energy in tapered plasmonic waveguides," Phys. Rev. Lett. **93**, 137404 (2004).

222. M. I. Stockman, "Ultrafast nanoplasmonics under coherent control," New J. Phys. **10**, 025031 (2008).

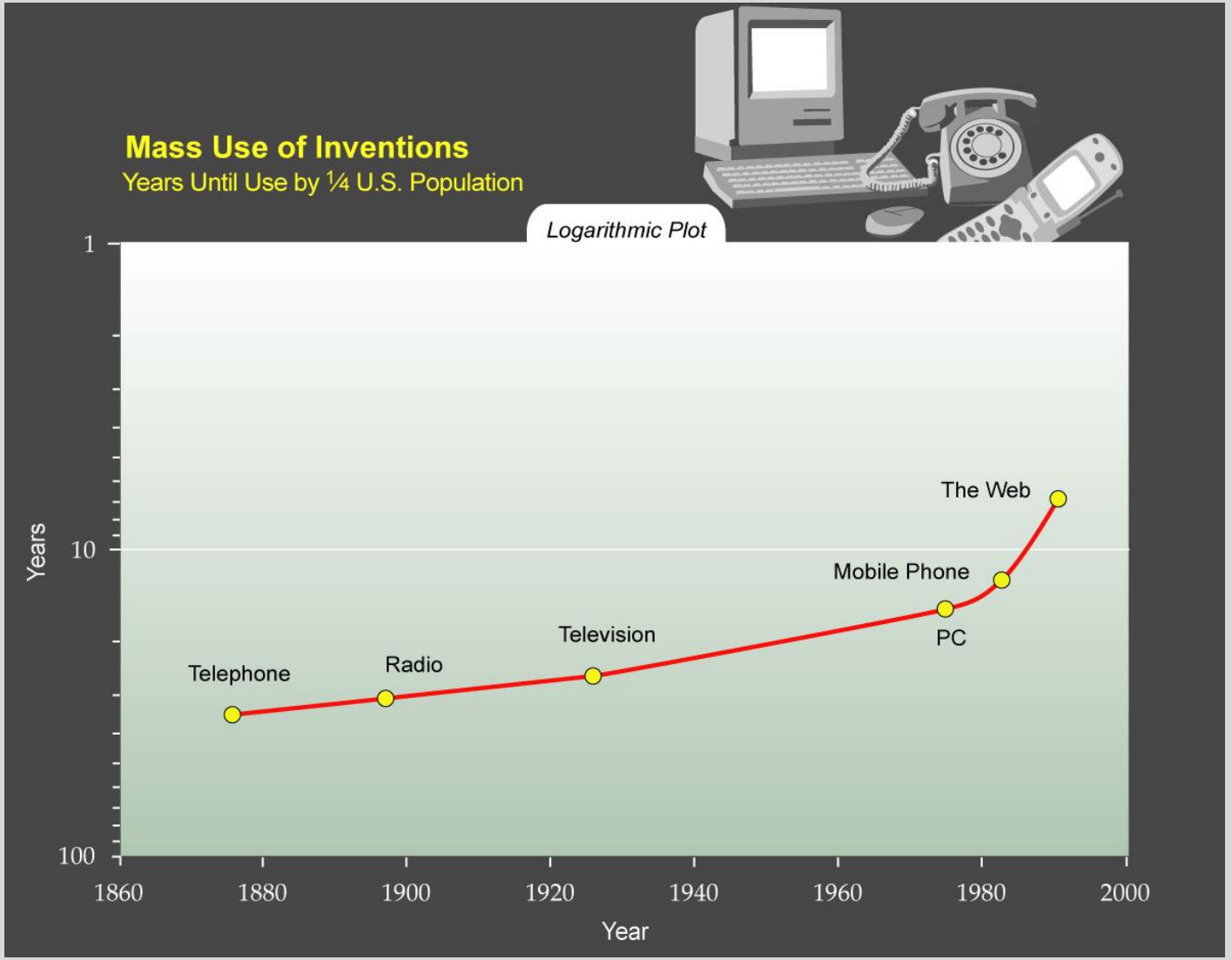
223. T. Brixner, F. G. de Abajo, J. Schneider, and W. Pfeiffer, "Nanoscopic ultrafast space-time-resolved spectroscopy," Phys. Rev. Lett. **95**, 093901 (2005).

224. M. Sukharev and T. Seideman, "Phase and polarization control as a route to plasmonic nanodevices," Nano Lett. **6**, 715–719 (2006).

225. M. Aeschlimann, M. Bauer, D. Bayer, T. Brixner, F. G. de Abajó, W. Pfeiffer, M. Rohmer, C. Spindler, and F. Steeb, "Adaptive subwavelength control of nano-optical fields," Nature **446**, 301–304 (2007).

The point here is that the more complex our problem solving becomes, the more complex its required expression becomes

Hierarchical problem solving - inventions in use



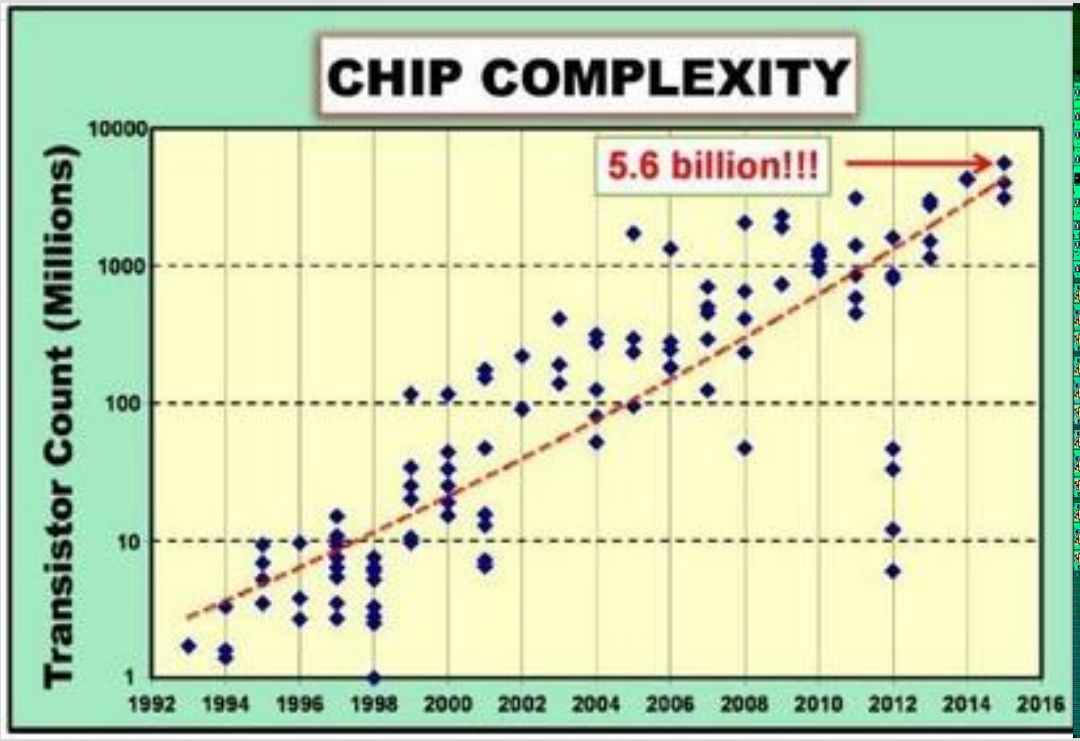
http://en.wikipedia.org/wiki/Accelerating_change

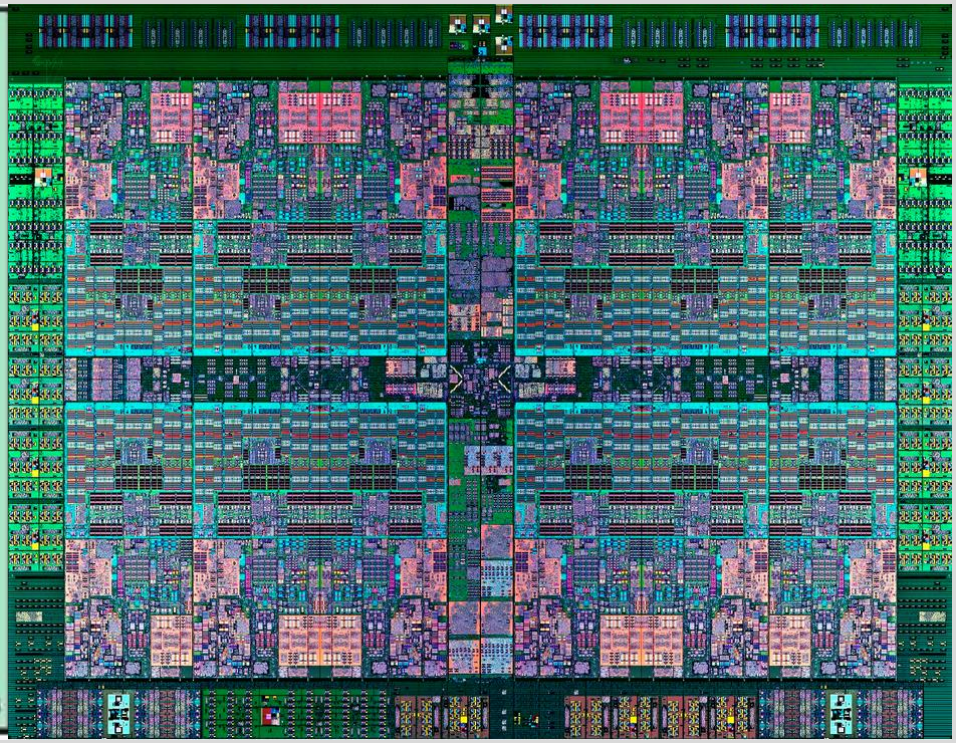
Why -> what -> how paradigm

Our technology is at the point where we can change/augment the ‘input’ or the whole system, but that needs a good understanding of ‘why’ we built the system like this in the first place (e.g. CRT/LCD raster scan).



Complexity of current designs





Consequence: the more complex our technology becomes, the more options to solve a problem we have

The more important becomes understanding WHY

www.eetimes.com/document.asp?doc_id=1324643

http://www.chipdesignmag.com/bursky/?p=184

Hierarchical problem solving (abstract)

- Two components:
  - Create abstract blocks: bound and box a solved problem such that solution can be passed as knowledge
  - Use abstract blocks without understanding them
- A new type of training is needed, as we need to go in that direction

Example: usage of most technology today (we use cell phone without understanding how they work)



Perception/Expression discrepancy

Near zero Out/In Information bandwidth

Evolution of expression example - 3D on 2D



Evolution of expression example - 4D in 3D



Evolution of expression through models – macro example



Visualizing macroscopic concepts – technology aiding perception

Evolution of expression through models – micro example



Visualizing microscopic concepts – technology aiding perception

Perception/Expression imbalance

The Input/Output Bandwidth imbalance: our abilities are heavy on acquiring information fast (e.g vision) but way less developed on passing acquired and developed knowledge (e.g. speech).



Perception/Expression imbalance – cause?

Could be an evolutionary trait: for survival, acquiring data fast seemed to be more important then passing solutions (supported by language developing relatively recently).



http://www.csicop.org/si/show/why_being_human_makes_evolution_hard_to_understand/

Perception/Expression Imbalance - effects

Our knowledge would evolve faster if our ability to express our own contributions would improve.



http://ec.europa.eu/digital-agenda/en/collective-awareness-platforms-sustainability-and-social-innovation

Perception/Expression Imbalance – solutions?



http://www.learning-mind.com/direct-brain-to-brain-communication-at-a-distance-proven-possible/

Maybe Vulcan mind meld?



Perception/Expression Imbalance – not yet…



http://www.learning-mind.com/direct-brain-to-brain-communication-at-a-distance-proven-possible/

AI? WHAT? Why?

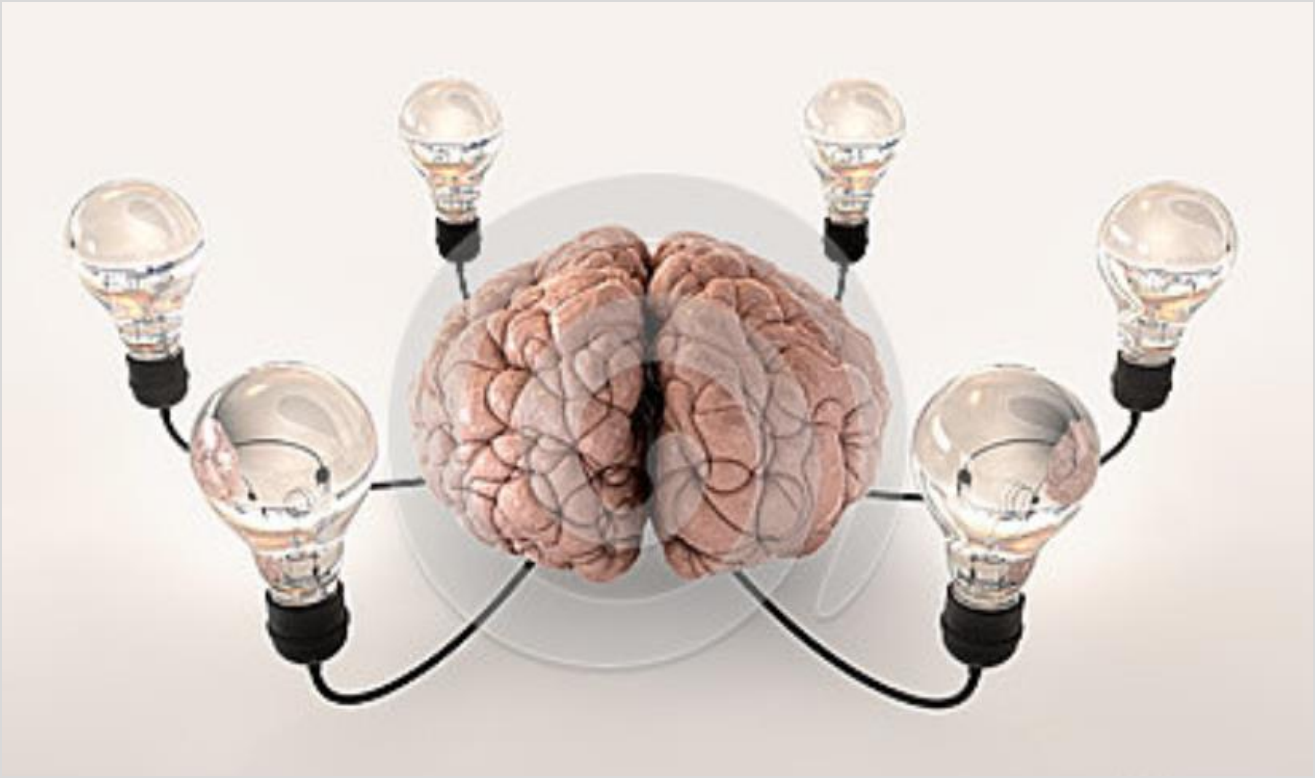
- We are limited in time
- Technology could help us:
  - Give us more time
  - Accelerate our ‘thinking’

‘The goal isn’t to replicate human brains. This isn’t about replacing human thinking with machine thinking. We just want our smart machines to make us smarter.’

Smart Machines: IBM's Watson and the Era of Cognitive Computing



•Kurzveil arg: the singularity and the rise of AI is needed only in the event our ‘organic’ evolution is inferior to our ‘technological’ evolution, but this balance is not set, and the past shows that ‘organic’ one generated the other.



Thinking (move calculations) outside of Brain

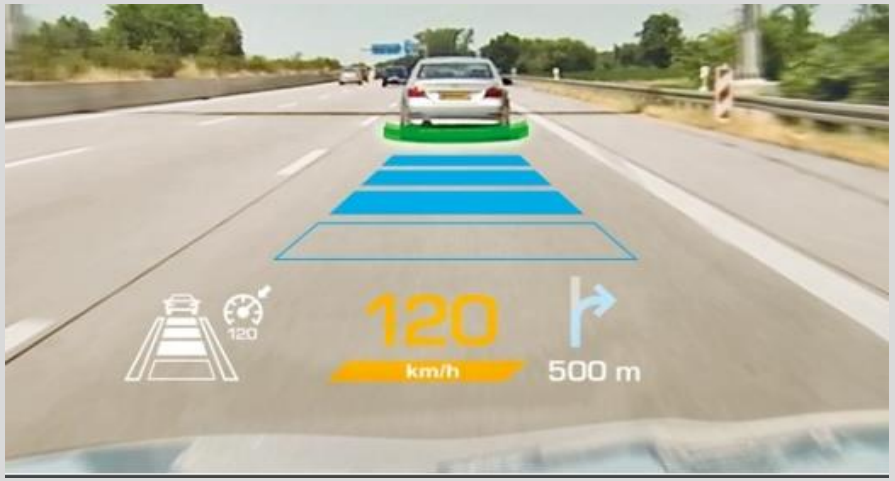
Information revolution and new problem solving challenges

Technology aid to perception



- Visualization of data plays an important role
- Augment perception such that incoming information is filtered and presented in a simplified model form.
- Hierarchical perception would enable hierarchical thinking

Augmenting incoming information





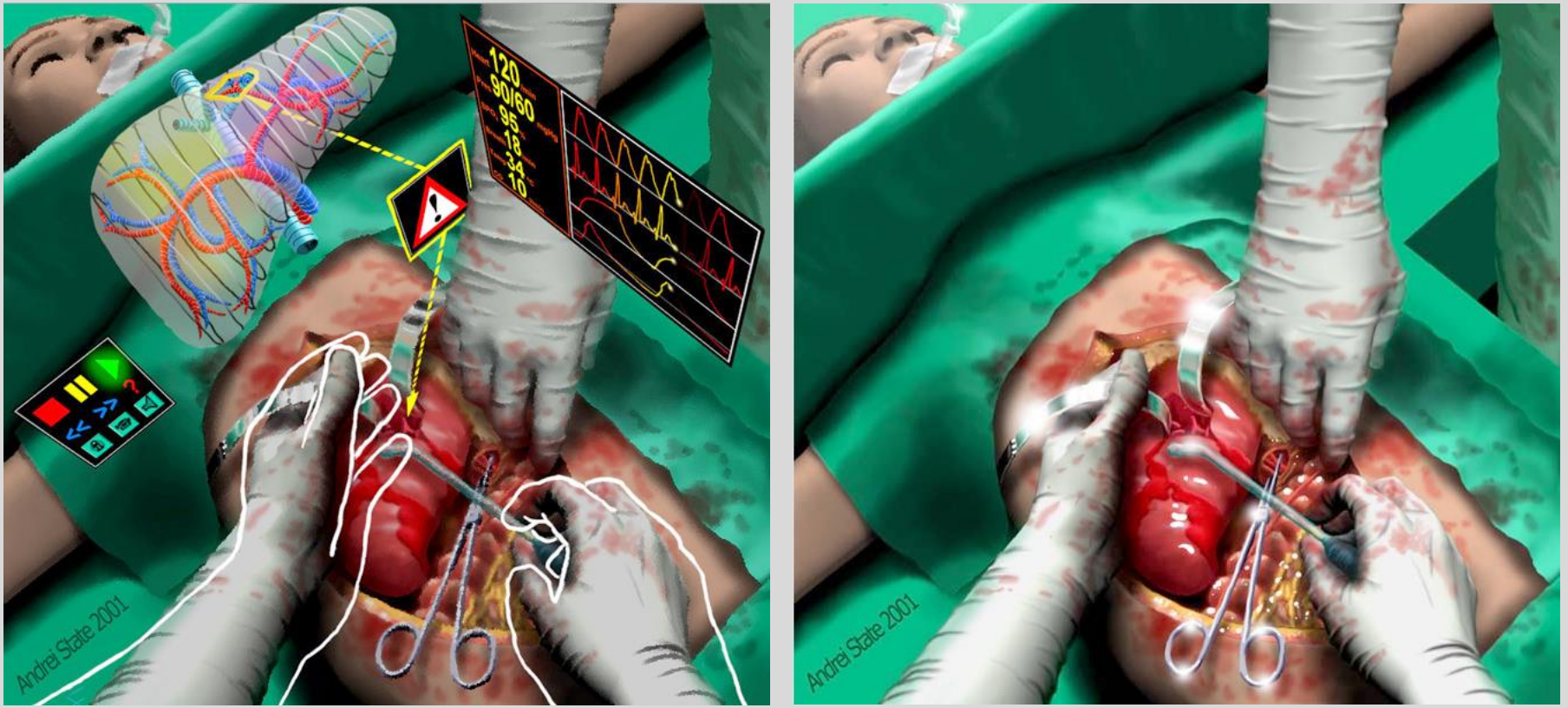




The time we spend on filtering and analyzing information is decreasing allowing us to make more complex decision faster.

http://www.tomshardware.com/reviews/2013-audi-a8l

Immersive electronic books – digital training



On -demand access to learning allows us to acquire more knowledge and tackle more complex problems

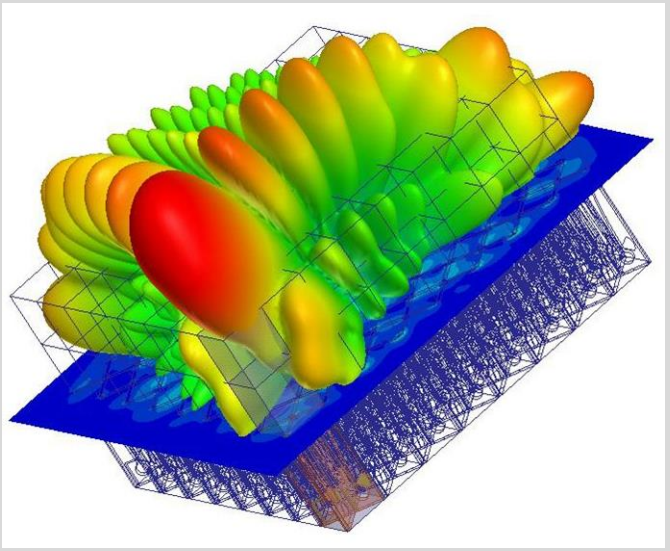
http://www.cs.unc.edu/Research/stc/Projects/ebooks.html

Digital prototyping and CAD/EDA revolution

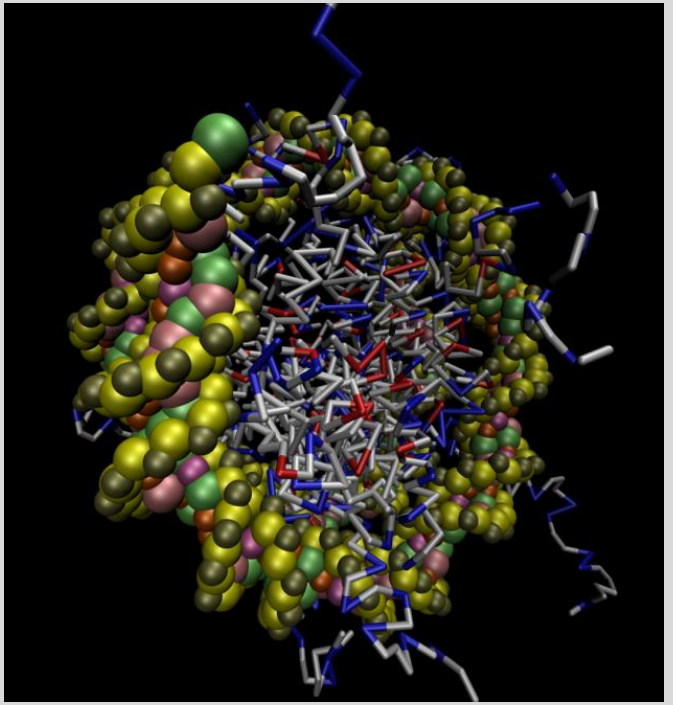
Current advances in modeling and simulations allow ‘digital prototyping’ but require a new class of problem solving abilities.



http://www.theonecar.com/wp-content/uploads/2014/01/bugatti-veyron-engine-1300.jpg



http://www.cadit.com.sg/imagestore/userfiles/image/em-antenna-bg.jpg



http://www.isgtw.org/feature/high-throughput-computing-and-shape-dna-come

CAD tools are prevalent in engineering

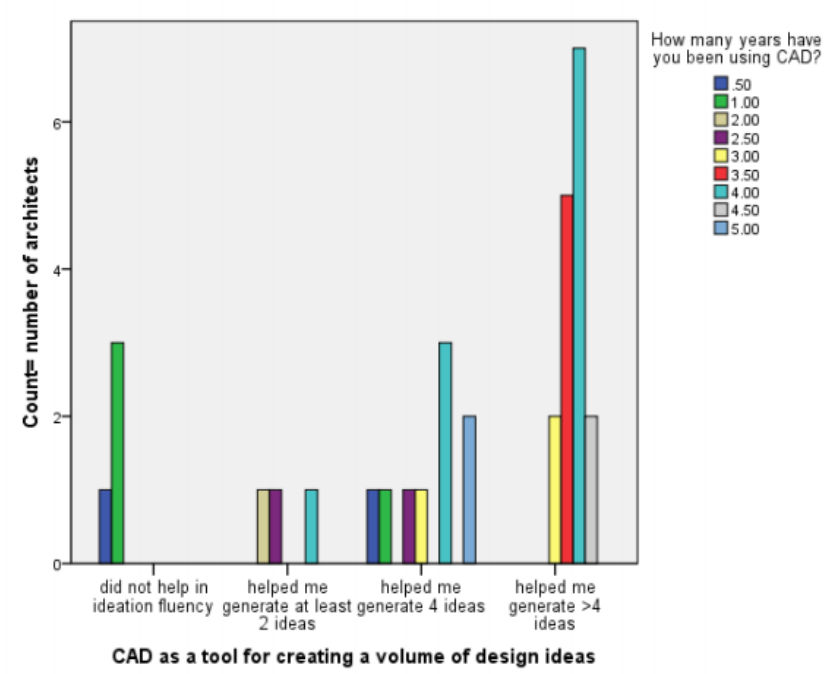


Figure 1. Number of architects in each experience category (Y-axis) against volume of design ideas (X-axis)

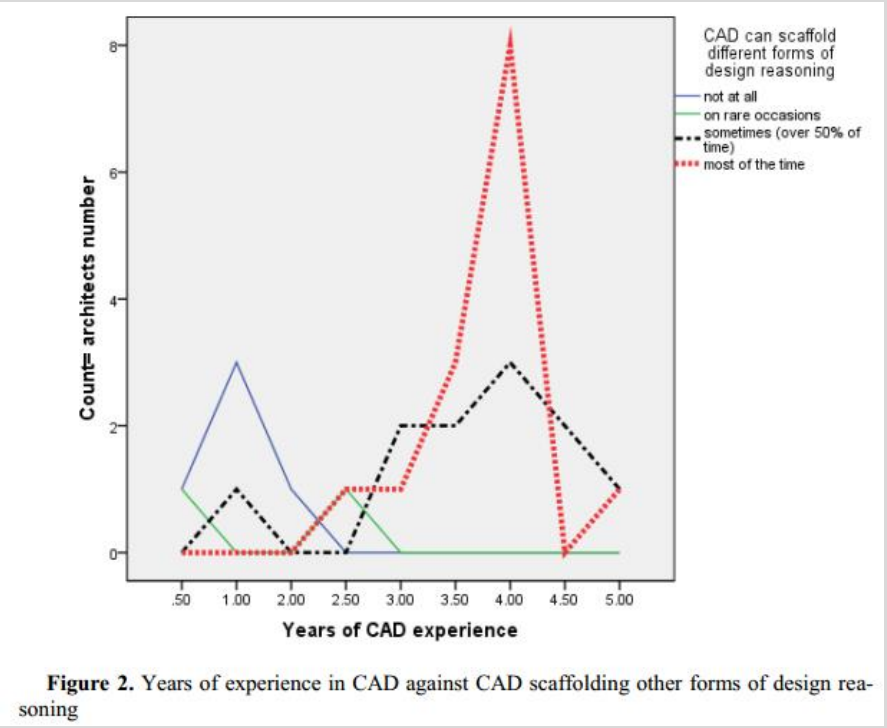


Figure 2. Years of experience in CAD against CAD scaffolding other forms of design reasoning

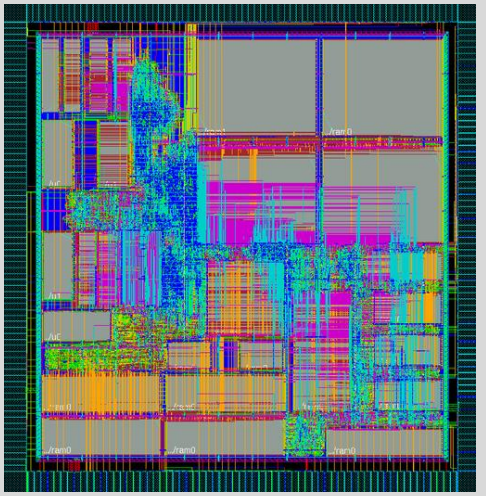
R.Hanna - Tools as Design Instruments: Computers and Cognition? (2013)

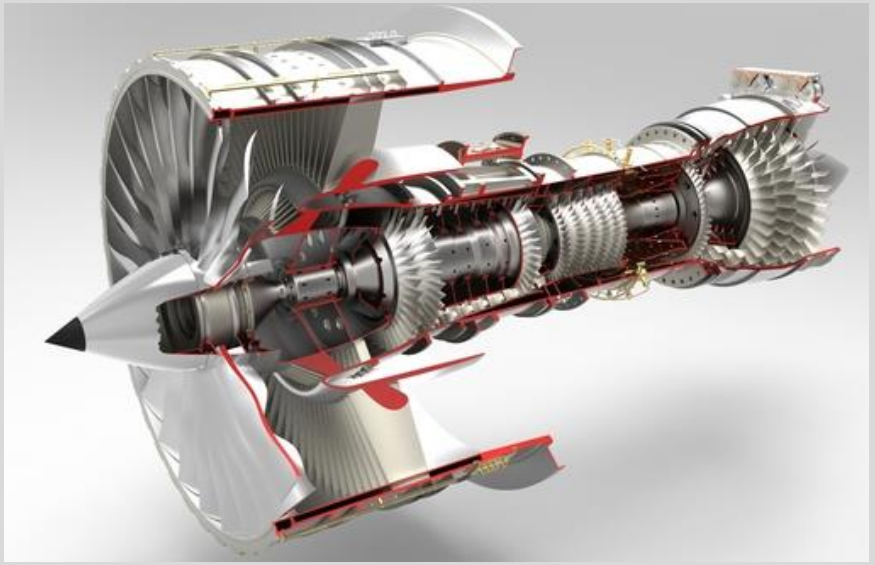
Thinking outside of brain

CAD/EDA tools are not only visualization aids but tools that enable hierarchical thinking (HT) - this ability is needed to make use of modeling and CAD/EDA computer sw packages.

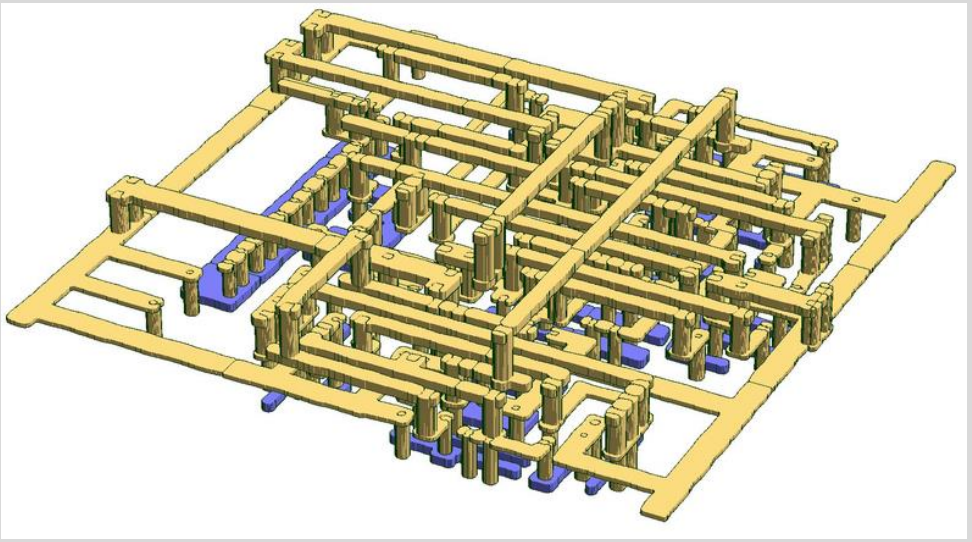
Currently HT used in engineering:

- Is a result of training as opposed to learning
- Is exercised by 'experts' in the field



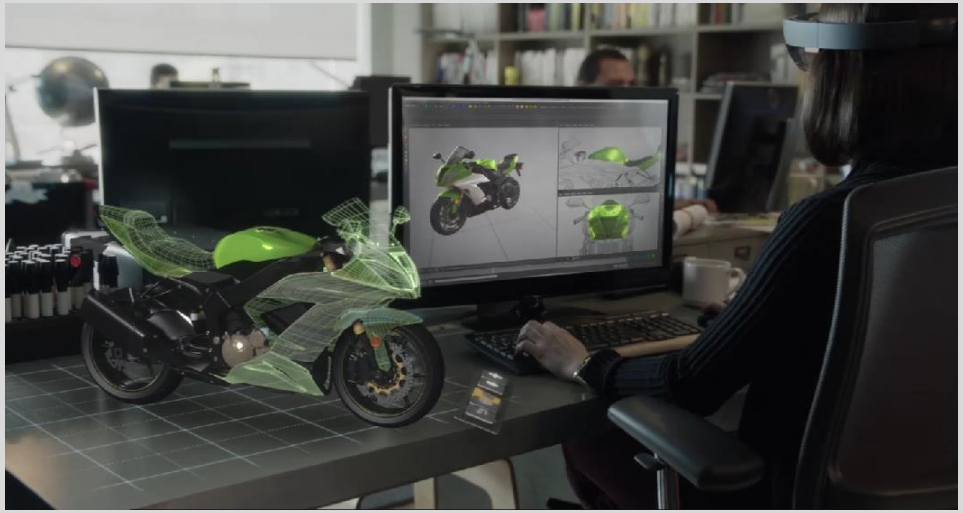


http://grabcad.com/library/jet-engine--2

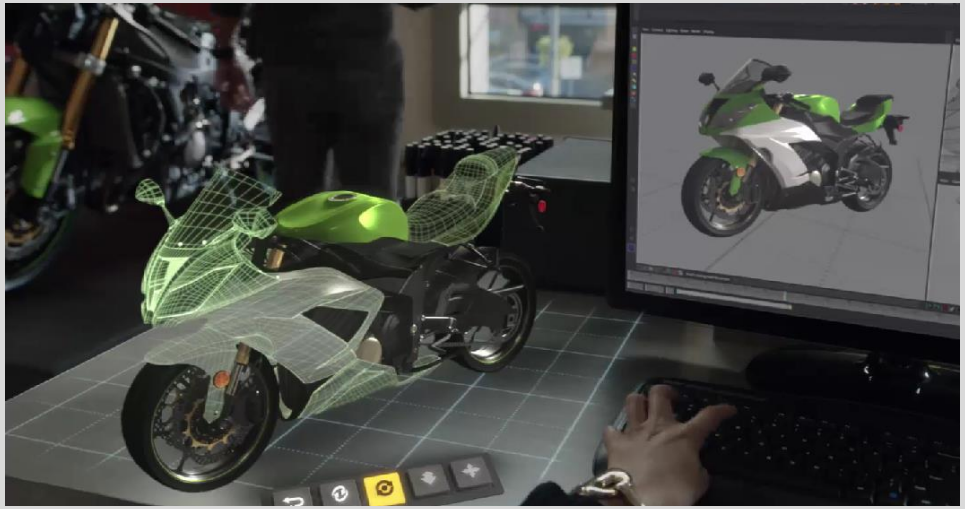


http://www.cadence.com

CAD aid to cognition









How in the near future we should be able to do this

http://www.microsoft.com/microsoft-hololens/en-us

NOT really hierarchical problem solving









http://hardware.daqri.com/smarthelmet/

Summary

1. there is a saturation point for each technology - quantitatively: when a specific technology cannot be scaled in a feasible way anymore - that technology needs to morph into a new one;
2. we are approaching a complexity saturation point, where the complexity of the problems we are trying to solve is to much for the methods we are using ;
3. the more complex problems we solve, the more complex ways to store and express the results we need;
4. with this complexity, it becomes hard to really understand the full system, but that is needed in order to utilize the technology - the why-what-how paradigm;
5. there is an imbalance between our ability to absorb information and our ability to express ideas - our input data bandwidth is much more than our output data bandwidth;
6. thinking outside of brain - this is a possible solution to 5
7. thinking outside of brain uses technology to create designs and complex solutions in a virtual medium (a computer) making us manipulating abstract quantities to generate real solutions.

Future research questions

Develop training methods, envision use-cases and user-interfaces

- Improving the perception/expression imbalance: use CAD/EDA like tools for expression and augment with models real data.
- Thinking (moving calculations) outside of brain: encapsulate data and use models.
- Why -> What -> How paradigm: contextual problem solving.

Ideally, we'd want mobile technology to have a rigorous requirement rather than be driven by empiric utilization, and for that help is needed from the human vision community.

End – A&Q

Discussion

Side track

SNR as a measure of evolution?

(numerical precision - today)

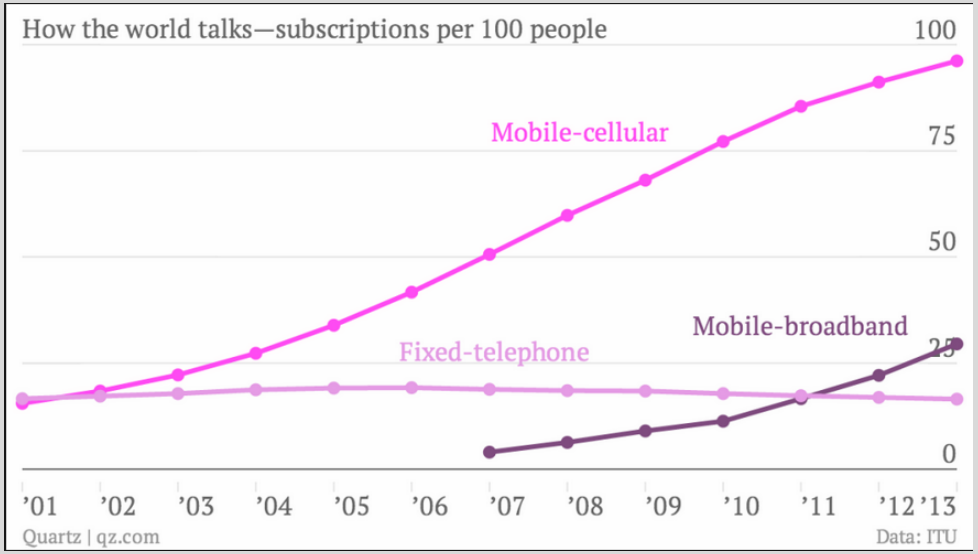
- Signal vs noise dilemma = signal is what we know, noise is what we don’t know – or might be too hard to quantify
- Digital representation of numbers over the last years is an indirect indication.
- Why we use today floats (double)? Because we can!



Technology growth in data storage and communication

We have good communication technologies and good data storage technologies – so the weakest link now is somewhere else: **how to use those technologies to help the human race overcome its biological limits?**

By 2013, there were some 96 cell-phone service subscriptions for every 100 people in the world



http://qz.com/179897/more-people-around-the-world-have-cell-phones-than-ever-had-land-lines/

