



# Digital Disruption in the Laboratory: Joined-Up Science?

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Then.....





## Then..... and Now





# Evolution of digital technologies

- ◆ User experience
  - Fixed character cell -> GUI -> Gesture-based
- ◆ Connectivity
  - Central system / dumb terminal
  - Client – server / networks
  - WWW
  - WiFi
  - Bluetooth
- ◆ Search tools
- ◆ Social Networks
- ◆ Mobile
  - Cloud / Smart Phones / Tablets
- ◆ Big data / Data analytics
- ◆ Wearables? Internet of Things?



# A digital revolution in science?

- ◆ Communications
- ◆ Music
- ◆ Movies/Video/TV
- ◆ Publishing
- ◆ Photography
  
- ◆ Digital technologies are disruptive
  - They democratise industry sectors
  - They separate content from consumables & devices
  - They require that intellectual property be managed differently
  - They require different business models



# Business constraints in the Laboratory

- ◆ Regulatory (inc. Health, Safety, Environmental)
- ◆ IP Protection, Legal, Patents, Corporate Governance
- ◆ The Scientific Method
  - Data curation
  - Data provenance
  - Data integrity
  - Data preservation



# Business/Scientific/Technology issues

## ◆ Business Issues

- Productivity
- Hierarchies -> Networks (communication/collaboration)
  - ◆ Externalisation (low cost commodity services)
  - ◆ Innovation (geographically dispersed expertise)

## ◆ Science

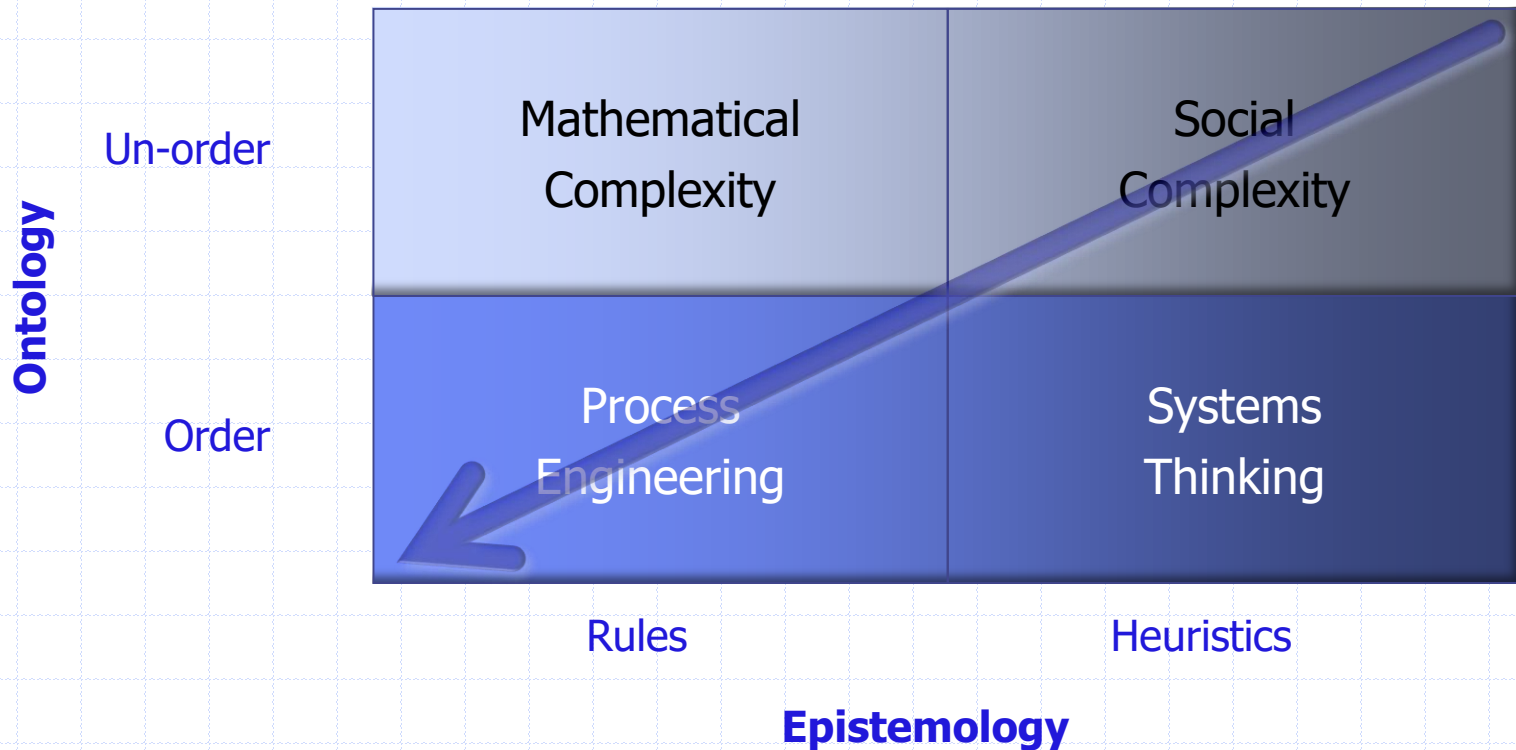
- Chemistry -> Biology
  - ◆ More complex
  - ◆ More data
  - ◆ Less certainty

## ◆ Technology

- Cloud/Mobile/Modularity
- Social Networks
- Convergence (best of breed vs one size fits all)
- Big data/Data analytics



# The 'Management' Landscape



Source : Multi-Ontology Sense Making, David Snowden, Management Today Yearbook 2005



## Being a scientist.....

"Being a scientist requires having faith in uncertainty, finding pleasure in mystery, and learning to cultivate doubt." \*

"Science traffics in ignorance, cultivates it, and is driven by it. Mucking about in the unknown is an adventure; doing it for a living is something most scientists consider a privilege." \*

\* *"Ignorance: How it Drives Science", Stuart Firestein, OUP USA, 2012*

"Computers are incredibly fast, accurate, and stupid. Human beings are incredibly slow, inaccurate, and brilliant. Together they are powerful beyond imagination." *Albert Einstein*

"...inefficient practices have become deeply ingrained by a highly risk averse and legalistic corporate culture, often at the expense of opportunities to co-develop early-stage technology tools, establish data standards, share disease target information, or pursue other forms of collaboration that could lift the productivity of the entire industry."

*Macrowikinomics, Don Tapscott & Anthony D. Williams, Atlantic Books, 2010*



# The 'Management' Landscape

**Ontology**

Un-order

Order

|                         |                   |
|-------------------------|-------------------|
| Mathematical Complexity | Social Complexity |
| Process Engineering     | Systems Thinking  |

Rules

Heuristics

**Epistemology**

Source : Multi-Ontology Sense Making, David Snowden, Management Today Yearbook 2005



## Do we have the right skill sets?

- ◆ The nature of lab work changes as we move from manually executed processes to automated processes.
- ◆ Algorithms, software, hardware and digital manufacturing are the new standards of product design.
- ◆ Education (understanding) vs. training (doing)
- ◆ What happens when cognitive skills are not required?

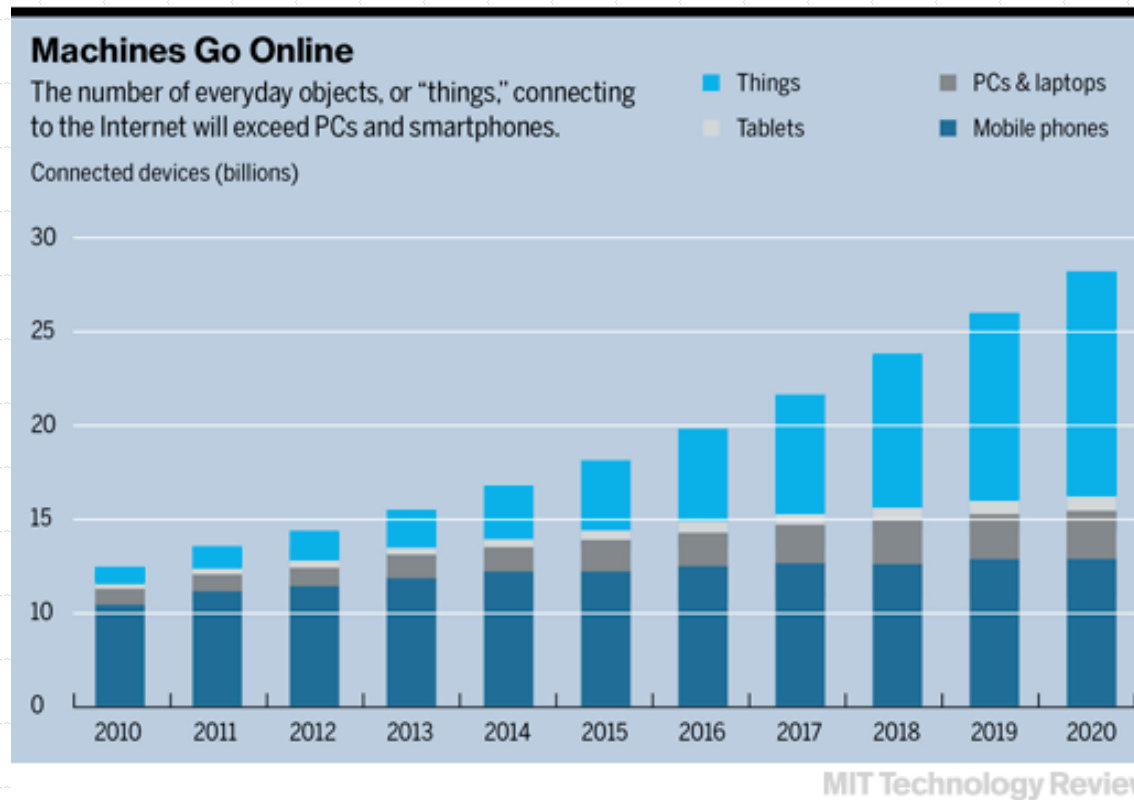
*'A routine is a number of stereotypical behaviours which can be performed without troubling the idling brain. Routines must always make sense, even if the only sense is to hamper constructive thought.'*

*'Stickleback', John McCabe, Granta Books, London*



# The Internet of Things

- ◆ Industrial Internet (<http://ieet.org/index.php/IEET/more/muzyka20140601>)
  - Interconnected devices with machine-to-machine protocols



- ◆ "Every industrial company will become a software company" Geoff Immelt, CEO General Electric



# The digital transformation of science

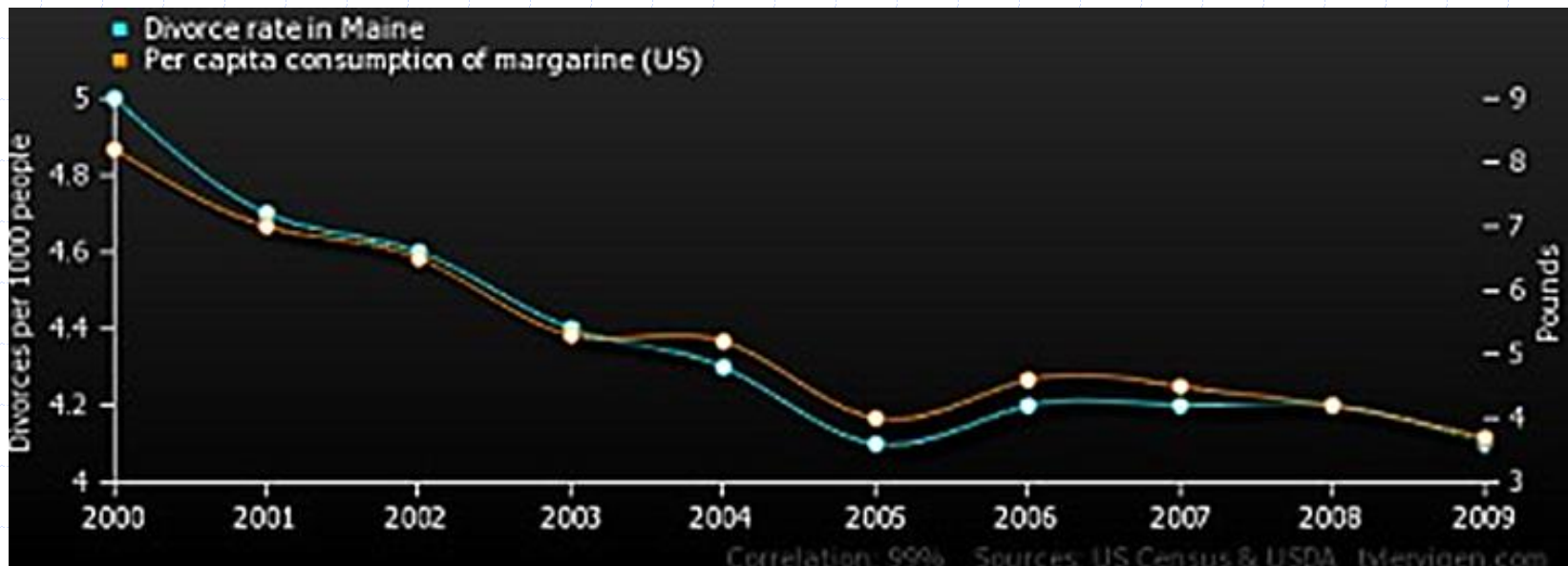
- ◆ Unprecedented opportunities for pre-competitive collaboration to support innovation
  - Establish business models that accommodate and support innovation
  - Enhance scientific collaboration by learning from consumer 'social' technologies (push instead of pull)
- ◆ Better educational systems to help scientists handle converging scientific disciplines, technologies and analytics
- ◆ Automation & productivity vs. creativity & innovation
  - Shifting the emphasis from throughput to better science
  - Extending 'Laboratory Informatics' tools to include/integrate with data analytics
  - Modular systems that separate data from applications and devices

*Charles Darwin:* "It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change."



# Big Data

Garbage in: (Garbage out)<sup>2</sup> ??



Spurious Correlations: <http://www.tylervigen.com>