RESEARCH, INNOVATION, ENTREPRENEURSHIP:
THE NECESSARY CHAIN FOR SUSTAINED ECONOMIC GROWTH

Alberto Sangiovanni-Vincentelli

Start-ups (about 7 co-founded):

- Co-Founder, Member of the Board, Cadence Design Systems
- Co-founder Synopsys

Industry (strategy, organization and technology consulting):

- Science and Technology Advisory Board, General Motors
- Technology Advisory Council, United Technologies....

Private Equity and VC

- President, Strategy Committee, Italian Strategic Fund (8 Billion)
- Advisory Board (Walden International, Sofinnova, Innogest, Xseed)
- Investment Committee (Fondo Atlante, Fondo Next)

Or... A View from a Researcher to a Casual Entrepreneur

- Innovation in Action
- The Economic Engine and Research
- Some Disruptive Research

Innovation

- Innovation is not an option: «every job created in centers of excellence in innovation generates at least five other jobs in other domains (services, traditional industry, entertainment) and these jobs are paid way better than in other places» (E. Moretti, Berkeley)
- There is not a single way of innovatingo not confuse invention with innovation
- Leveraging research for innovation in:
    - Established companies
    - Start-ups

McKinsey's Disruptive Technologies

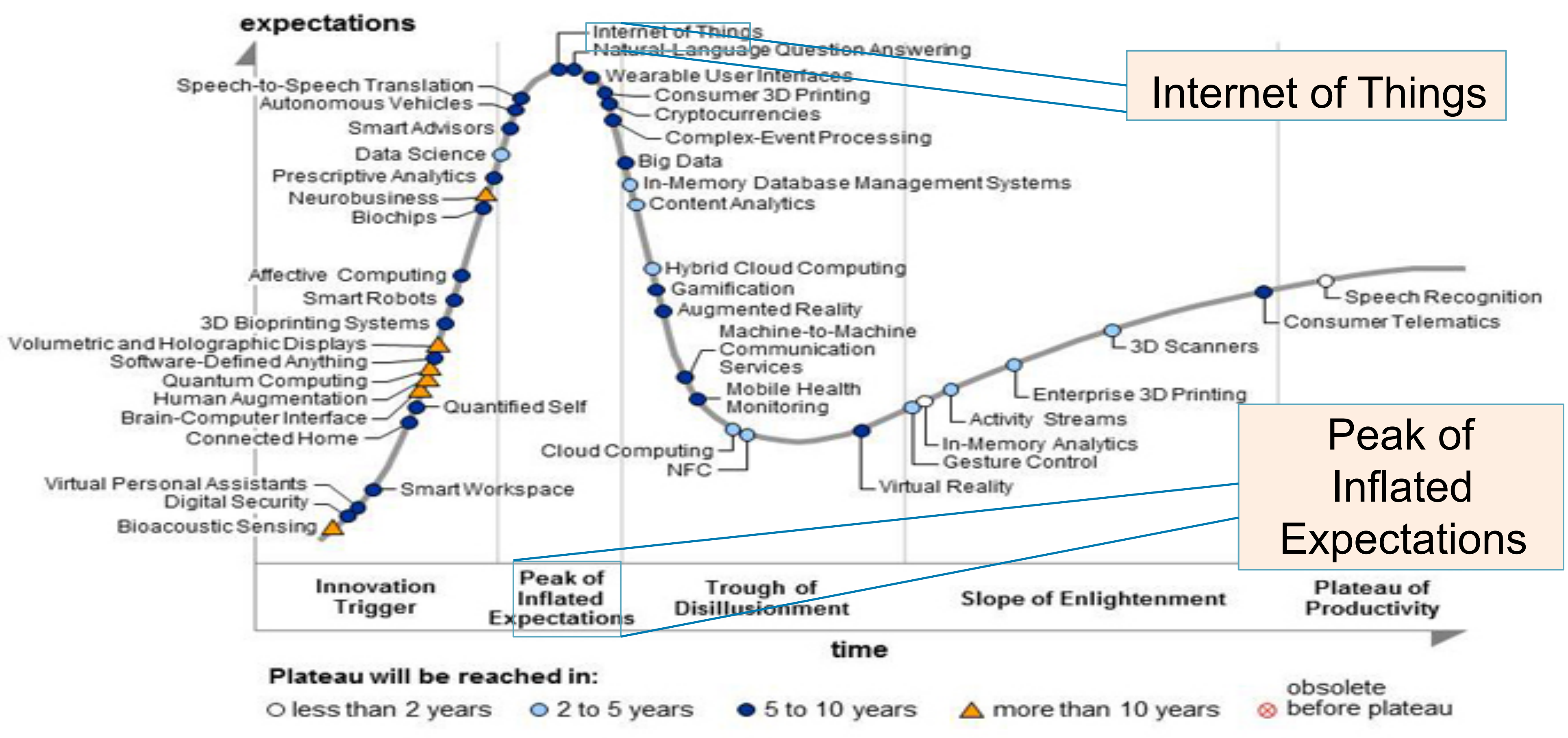
Twelve potentially economically disruptive technologies

Mobile Internet	Increasingly inexpensive and capable mobile computing devices and Internet connectivity
Automation of knowledge work	Intelligent software systems that can perform knowledge work tasks involving unstructured commands and subtle judgments
The Internet of Things	Networks of low-cost sensors and actuators for data collection, monitoring, decision making, and process optimization
Cloud technology	Use of computer hardware and software resources delivered over a network or the Internet, often as a service
Advanced robotics	Increasingly capable robots with enhanced senses, dexterity, and intelligence used to automate tasks or augment humans
Autonomous and near-autonomous vehicles	Vehicles that can navigate and operate with reduced or no human intervention
Next-generation genomics	Fast, low-cost gene sequencing, advanced big data analytics, and synthetic biology ("writing" DNA)
Energy storage	Devices or systems that store energy for later use, including batteries
3D printing	Additive manufacturing techniques to create objects by printing layers of material based on digital models
Advanced materials	Materials designed to have superior characteristics (e.g., strength, weight, conductivity) or functionality
Advanced oil and gas exploration and recovery	Exploration and recovery techniques that make extraction of unconventional oil and gas economical
Renewable energy	Generation of electricity from renewable sources with reduced harmful climate impact

Economic Potential

The Internet of Things	**300%** Increase in connected machine-to-machine devices over past 5 years **80–90%** Price decline in MEMS (microelectromechanical systems) sensors in past 5 years	**1 trillion** Things that could be connected to the Internet across industries such as manufacturing, health care, and mining **100 million** Global machine to machine (M2M) device connections across sectors like transportation, security, health care, and utilities	**$36 trillion** Operating costs of key affected industries (manufacturing, health care, and mining)
Cloud technology	**18 months** Time to double server performance per dollar **3x** Monthly cost of owning a server vs. renting in the cloud	**2 billion** Global users of cloud-based email services like Gmail, Yahoo, and Hotmail **80%** North American institutions hosting or planning to host critical applications on the cloud	**$1.7 trillion** GDP related to the Internet **$3 trillion** Enterprise IT spend
Advanced robotics	**75–85%** Lower price for Baxter[3] than a typical industrial robot **170%** Growth in sales of industrial robots, 2009–11	**320 million** Manufacturing workers, 12% of global workforce **250 million** Annual major surgeries	**$6 trillion** Manufacturing worker employment costs, 19% of global employment costs **$2–3 trillion** Cost of major surgeries
Autonomous and near-autonomous vehicles	**7** Miles driven by top-performing driverless car in 2004 DARPA Grand Challenge along a 150-mile route **1,540** Miles cumulatively driven by cars competing in 2005 Grand Challenge **300,000+** Miles driven by Google's autonomous cars with only 1 accident (which was human-caused)	**1 billion** Cars and trucks globally **450,000** Civilian, military, and general aviation aircraft in the world	**$4 trillion** Automobile industry revenue **$155 billion** Revenue from sales of civilian, military, and general aviation aircraft

Gartner Hype Cycle 2014



Google Strategy

CNET › Internet › Google closes $3.2 billion purchase of Nest

Google closes $3.2 billion purchase of Nest

The acquisition brings with it the Learning Thermostat and the Protect smoke and CO detector as Google looks to make its mark in the smart home.

by Lance Whitney @lancewhit / February 12, 2014 5:00 AM PST / Updated: February 12, 2014 5:19 AM PST

theguardian | TheObserver

Search

Google's drive into robotics should concern us all

The company's expansion into robotics was developed in tandem with the US military. Where will its power play stop?

John Naughton
The Observer, Sunday 29 December 2013

Google's robotic cars have about $150,000 in equipment including a $70,000 LIDAR (laser radar) system. The range finder mounted on the top is a Velodyne 64-beam laser. This laser allows the vehicle to generate a detailed 3D map of its environment. The car then takes these generated maps and combines them with high-resolution maps of the world, producing different types of data models that allow it to drive itself.

Google and Facebook

Google acquired Titan Aerospace, the drone startup that makes high-flying robots which was previously scoped by Facebook as a potential acquisition target, the WSJ reports.

The deal comes after Facebook disclosed purchase of U.K.-based Ascenta for its globe-spanning Internet plans.

Both Ascenta and Titan Aerospace are in the business of high altitude drones integral to blanketing the globe in cheap, omnipresent Internet connectivity to help bring remote areas online.

That's not all the Titan drones can help Google with, however. ***The company's robots also take high-quality images in real-time that could help with Maps initiatives, as well as contribute to things like "disaster relief" and addressing "deforestation,"….***

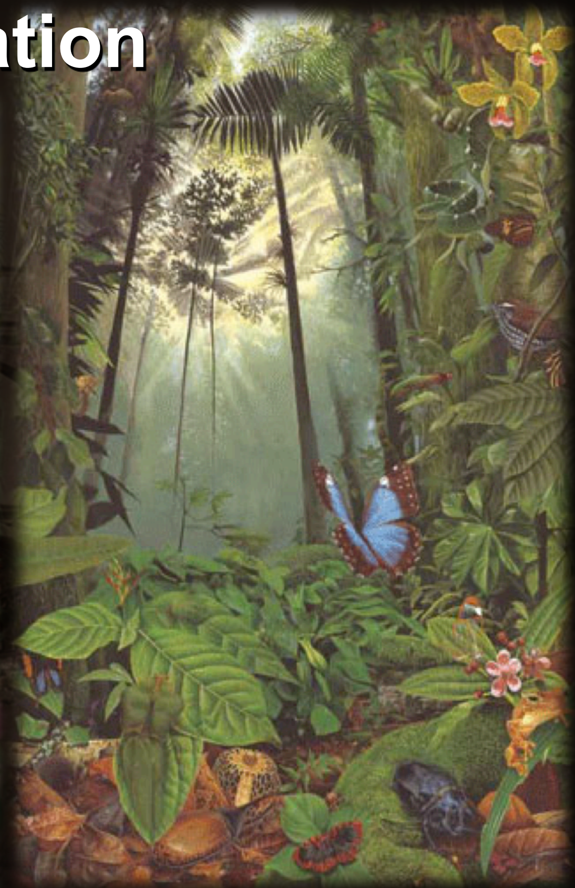
Apple

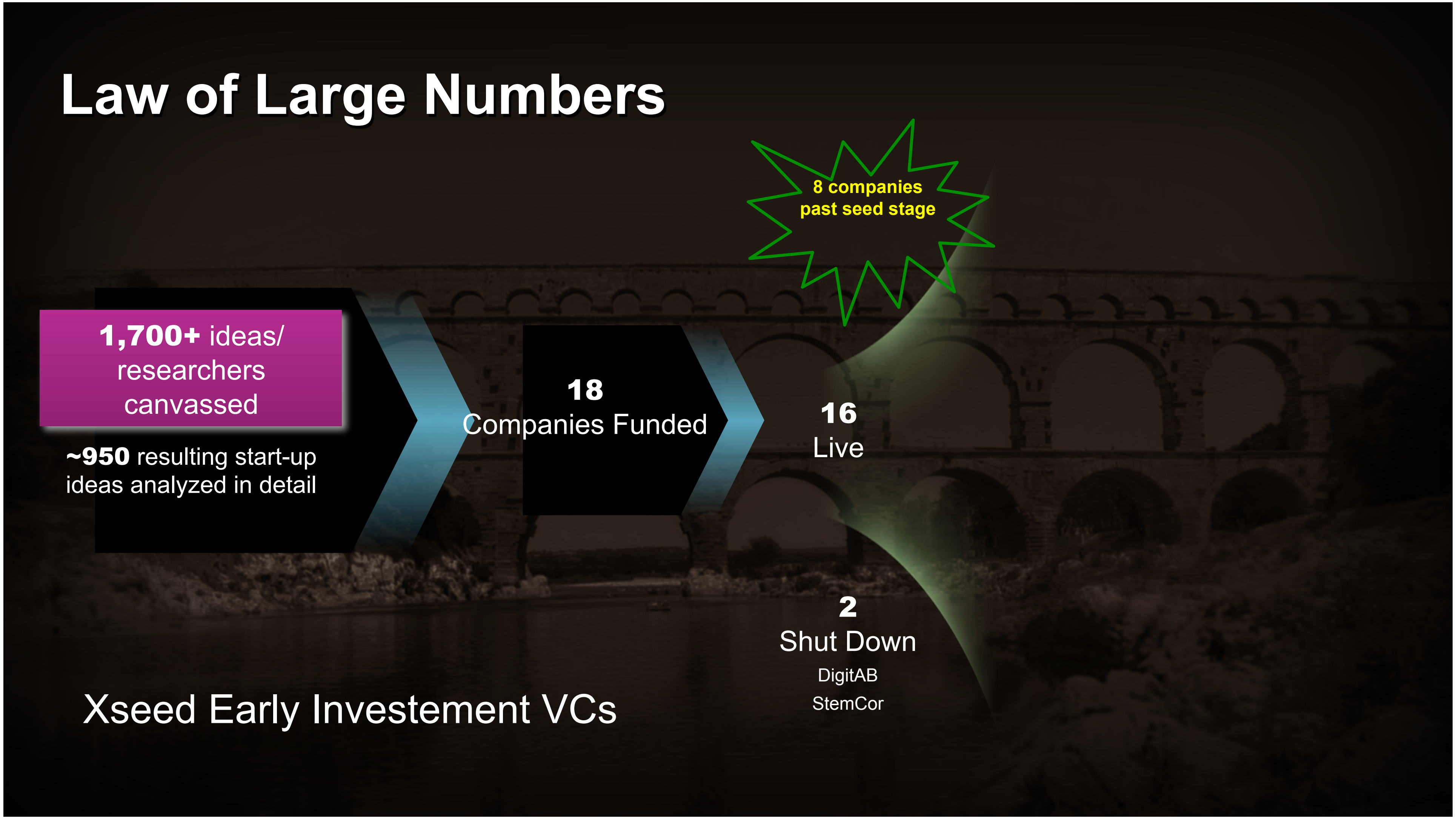
This week, years after that first sighting, Tesla announced plans for what it calls the "Gigafactory," a 10-million-square-foot plant for making car batteries. …But it's not just the prospect of a gasoline-free future that has sparked such excitement about the Gigafactory. The same basic lithium-ion tech that fuels Tesla's cars also runs most of today's other mobile gadgets, large and small. If Tesla really produces batteries at the scale it's promising, cars could become just one part of what the company does. **One day, Tesla could be a company that powers just about everything, from the phone in your pocket to the electrical grid itself.**

Earlier this month, as rumors swirled that Apple might want to buy Tesla, *San Francisco Chronicle* reported that **Tesla CEO Elon Musk had indeed met with the iPhone maker. Musk later confirmed that Tesla and Apple had talked, but he wouldn't say what about.**

Silicon Valley: The land of Innovation






Law of Large Numbers
8 companies
past seed stage
1,700+ ideas/
researchers
canvassed
~950 resulting start-up
ideas analyzed in detail
18
Companies Funded
16
Live
2
Shut Down
DigitAB
StemCor
Xseed Early Investement VCs

Liquidity and Returns: Exit Strategies

- Exit options
  - IPO
  - M&A

  - Bankruptcy
    - Chapter 7: basic liquidation; also known as straight bankruptcy;
    - Chapter 11: rehabilitation or reorganization, known as corporate bankruptcy, it typically allows companies to continue to function while they follow debt repayment plans;
  - Dissolution (Shutdown)
- Typical venture portfolio performance:
  - Out of every 10 investments
    - Half do not return capital
    - 1 returns >10X
    - Rest return 1-10X

What Drives Venture Returns?

- Market growth not absolute size
- Efficiency of capital deployment
- Irrational exuberance in exit markets
- A handful of big winners

And most of all

Fundamental Innovation—The (Tech) world isn't "flat"

Source: M. Borrus, Xseed

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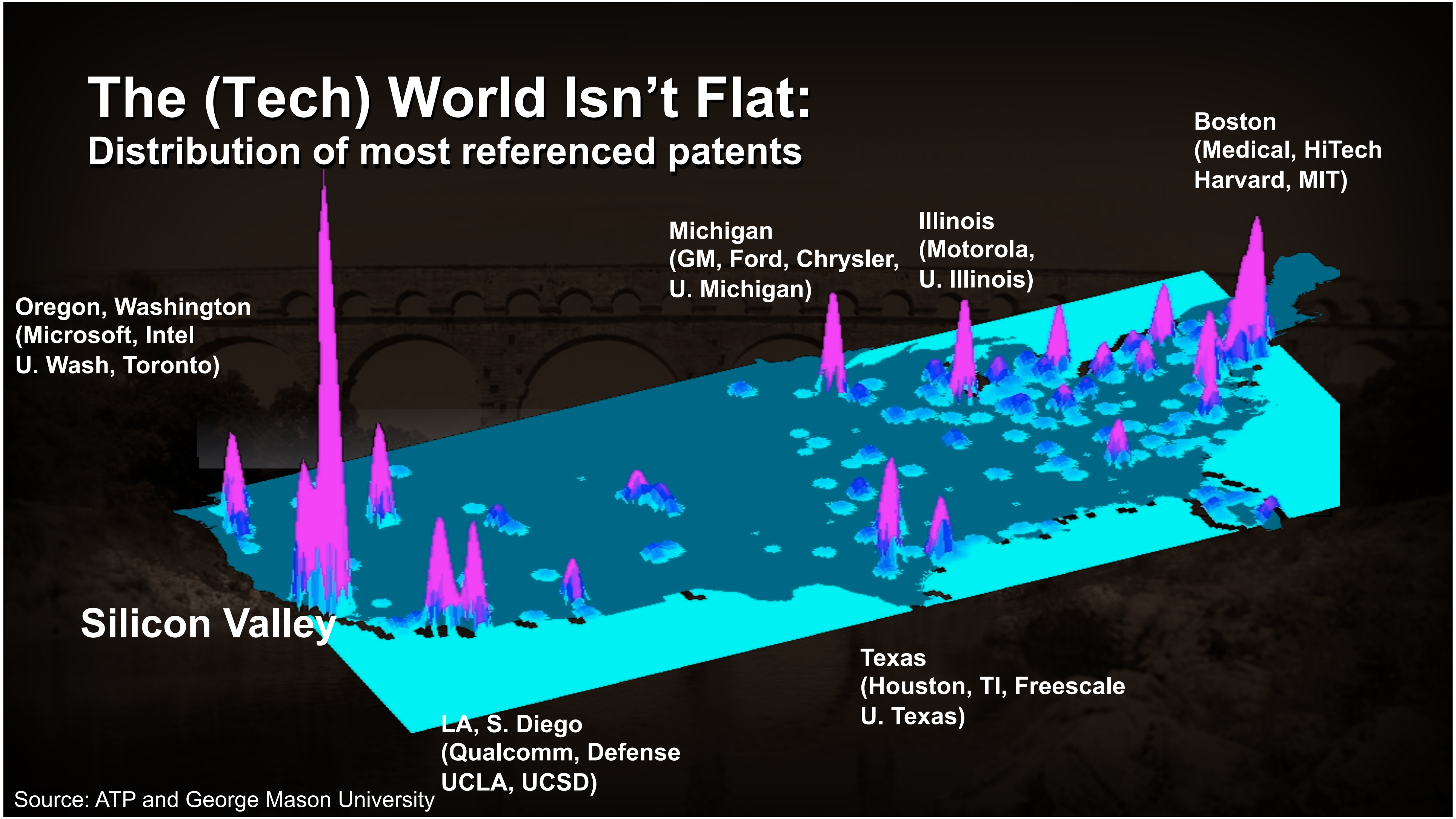
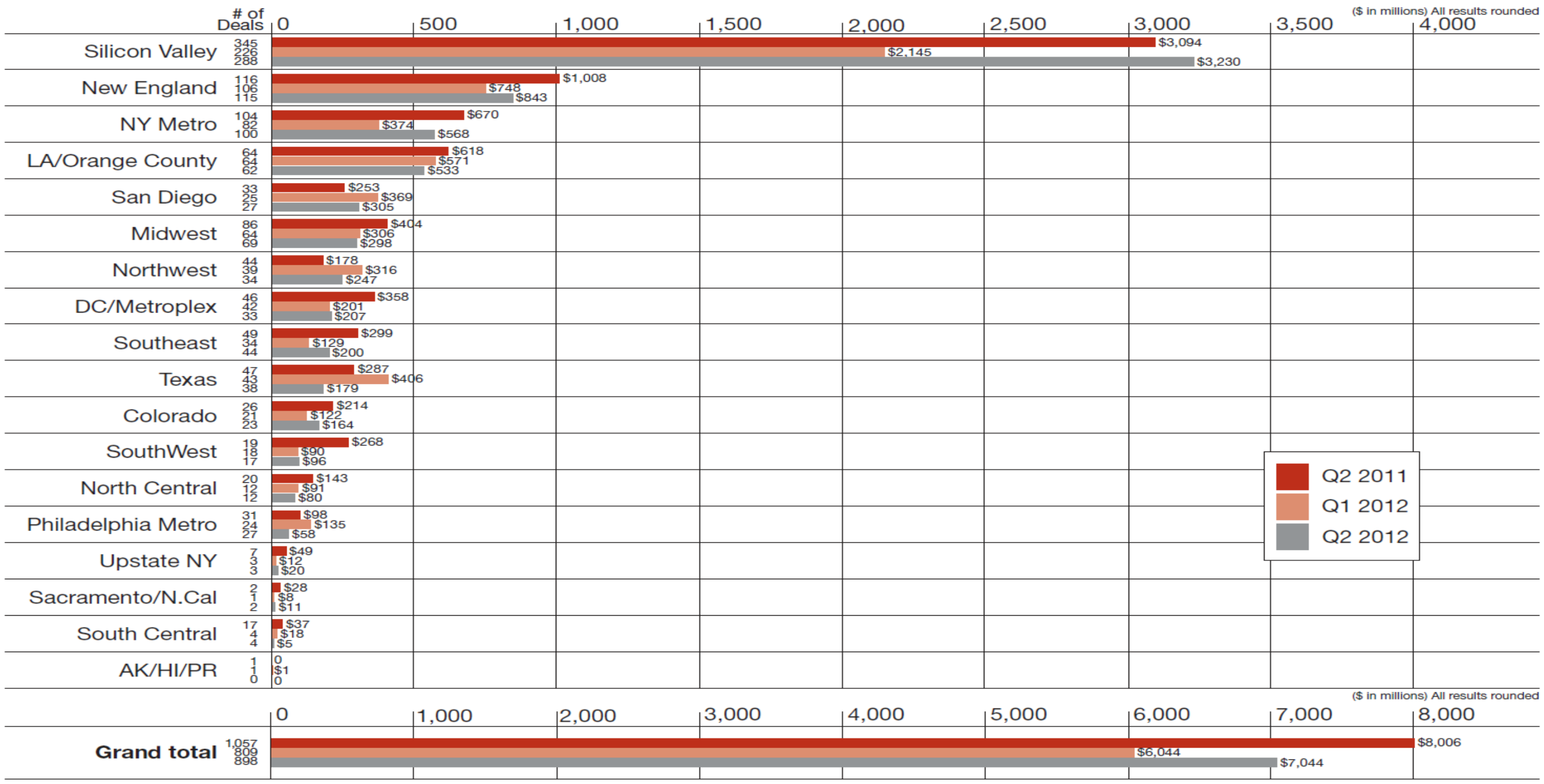

The (Tech) World Isn't Flat:
Distribution of most referenced patents
Boston
(Medical, HiTech
Harvard, MIT)
Michigan
(GM, Ford, Chrysler,
U. Michigan)
Illinois
(Motorola,
U. Illinois)
Oregon, Washington
(Microsoft, Intel
U. Wash, Toronto)
Silicon Valley
Texas
(Houston, TI, Freescale
U. Texas)
LA, S. Diego
(Qualcomm, Defense
UCLA, UCSD)
Source: ATP and George Mason University

Trend in Investment



U.S. VC-backed IPOs (2011-2014)

38 venture-backed companies raised $2.9 billion through public offerings in 1Q 2014. Number of deals increased by 90%, while capital raised registered a 17% decrease from the previous quarter.

The largest IPO of the quarter was Castlight Health Inc. (NYSE: CSLT), which completed a $178 million IPO.

U.S. VC-backed M&As (2011-2014)

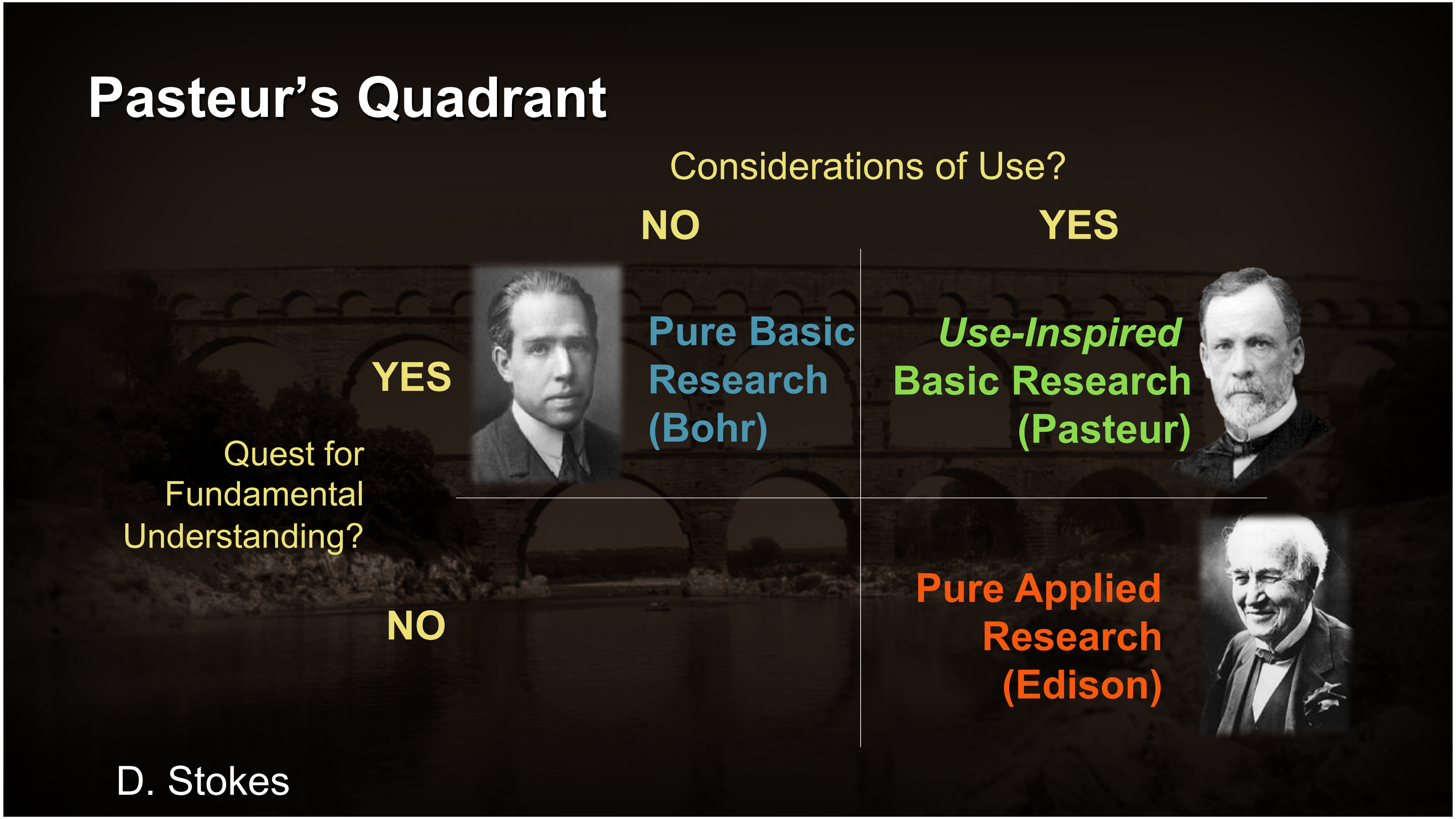
119 M&As of venture-backed companies in U.S. garnered $17 billion during 1Q 2014, the highest quarterly figure since 3Q 2000, when $23 billion were raised.

In contrast with 4Q 2013, when a total of 122 transactions accumulated $12 billion, though the number of M&As fell by 2%, the amount raised rose by 37%.

The largest M&A of the quarter was Nest Labs Inc., which was acquired by Google Inc. (Nasdaq: GOOG) for $3.2 billion.

The SCIENCE-Application Dilemma

Raffaello Sanzio, The Athens School


Pasteur's Quadrant
Considerations of Use?
NO
YES
YES
Pure Basic
Research
(Bohr)
Use-Inspired
Basic Research
(Pasteur)
Quest for
Fundamental
Understanding?
NO
Pure Applied
Research
(Edison)
D. Stokes

Research Centers-Industry Relationships

- Researchers should be rewarded on the basis of their contributions in all areas, including professional activities
- Reciprocal respect and attention to respective roles
- Beware of *patentitis*!!! “Speed not patents”
- Beware of *paperitis*!! More value less numbers
- Transfer of technology as viral infection!!!
  – Visiting professionals and industrial leaves
- Formation of new companies favored

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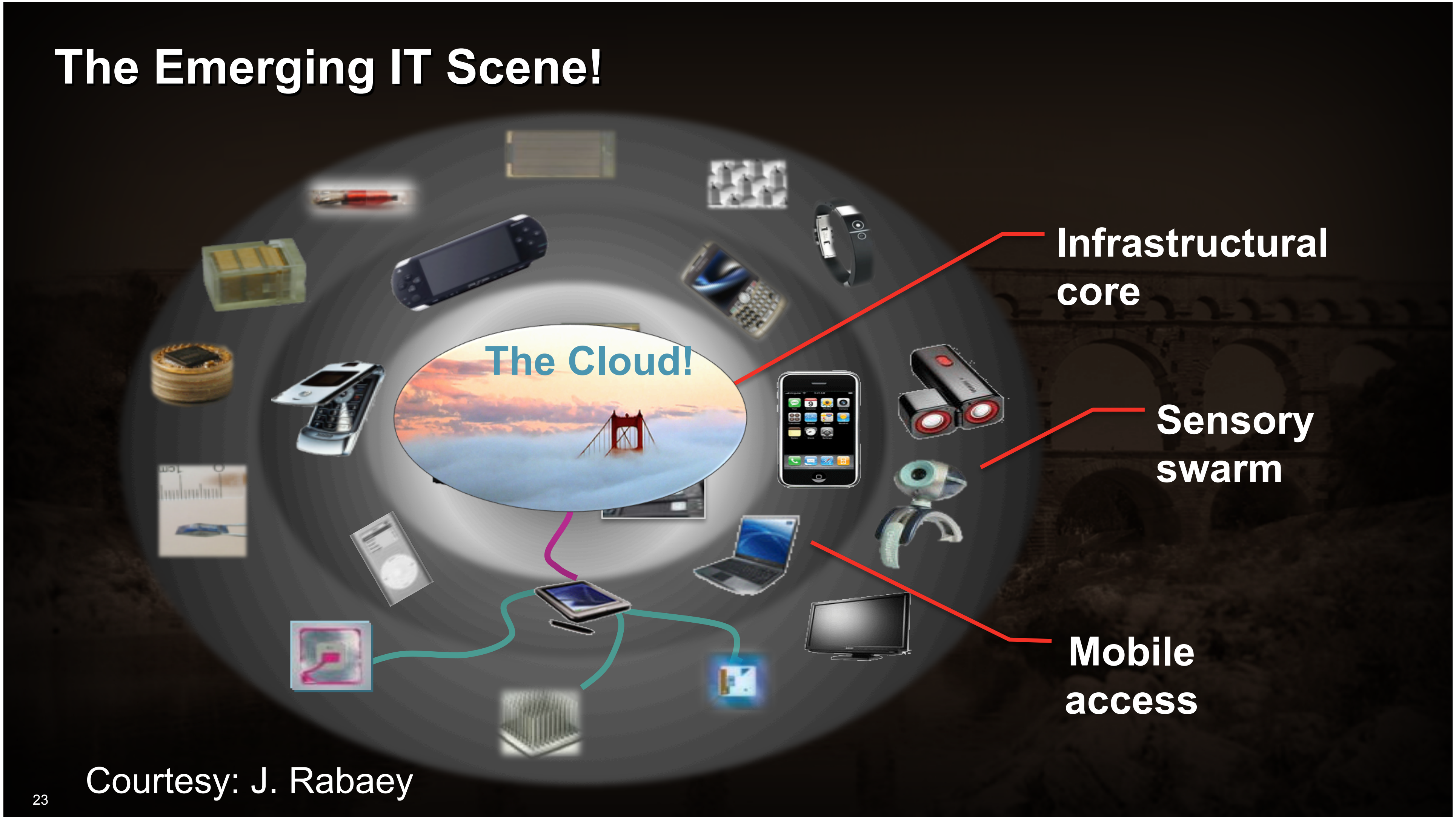

The Emerging IT Scene!
The Cloud!
Infrastructural core
Sensory swarm
Mobile access
Courtesy: J. Rabaey

Computers and mobiles to disappear!

Predictions: 7 trillions devices servicing 7 billion people!
1,000 devices per person by 2025

The Immersed Human

Real-life interaction between humans and cyberspace, enabled by enriched input and output devices on and in the body and in the surrounding environment

Courtesy: J. Rabaey

Another One: BioCyber (?) Systems

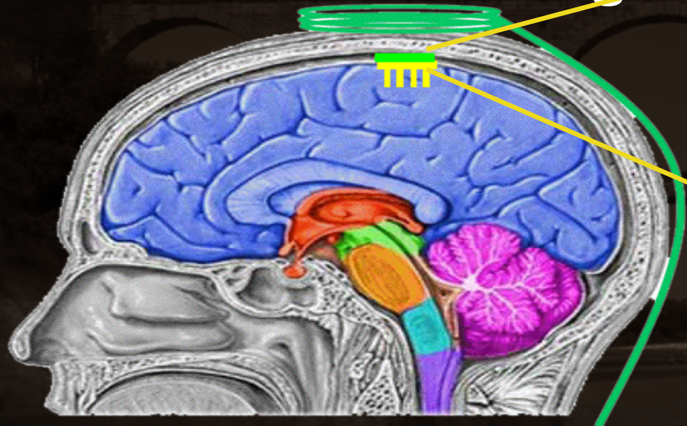
Linking the Cyber and Biological Worlds

Examples: Brain-machine interfaces and body-area networks

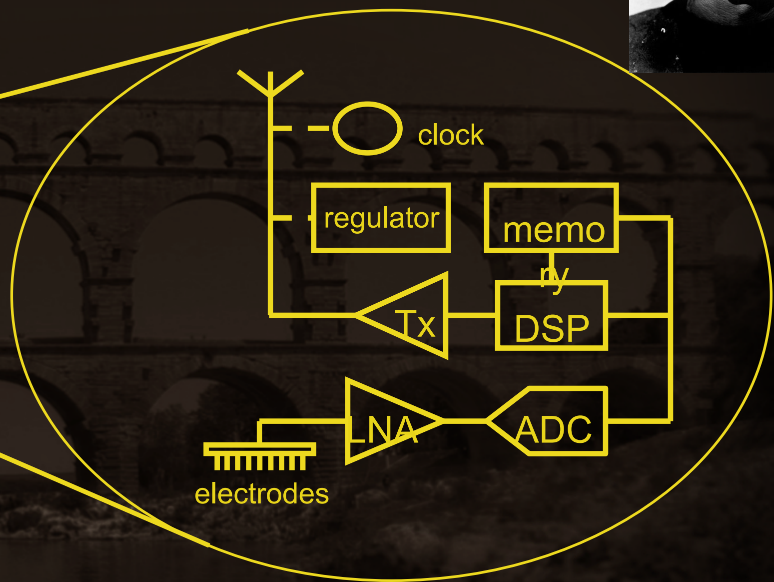
Courtesy: J. Rabaey

Towards Integrated Wireless Implanted Interfaces

Moving the state-of-the-art in wireless sensing



[Illustration art: Subbu Venkatraman]

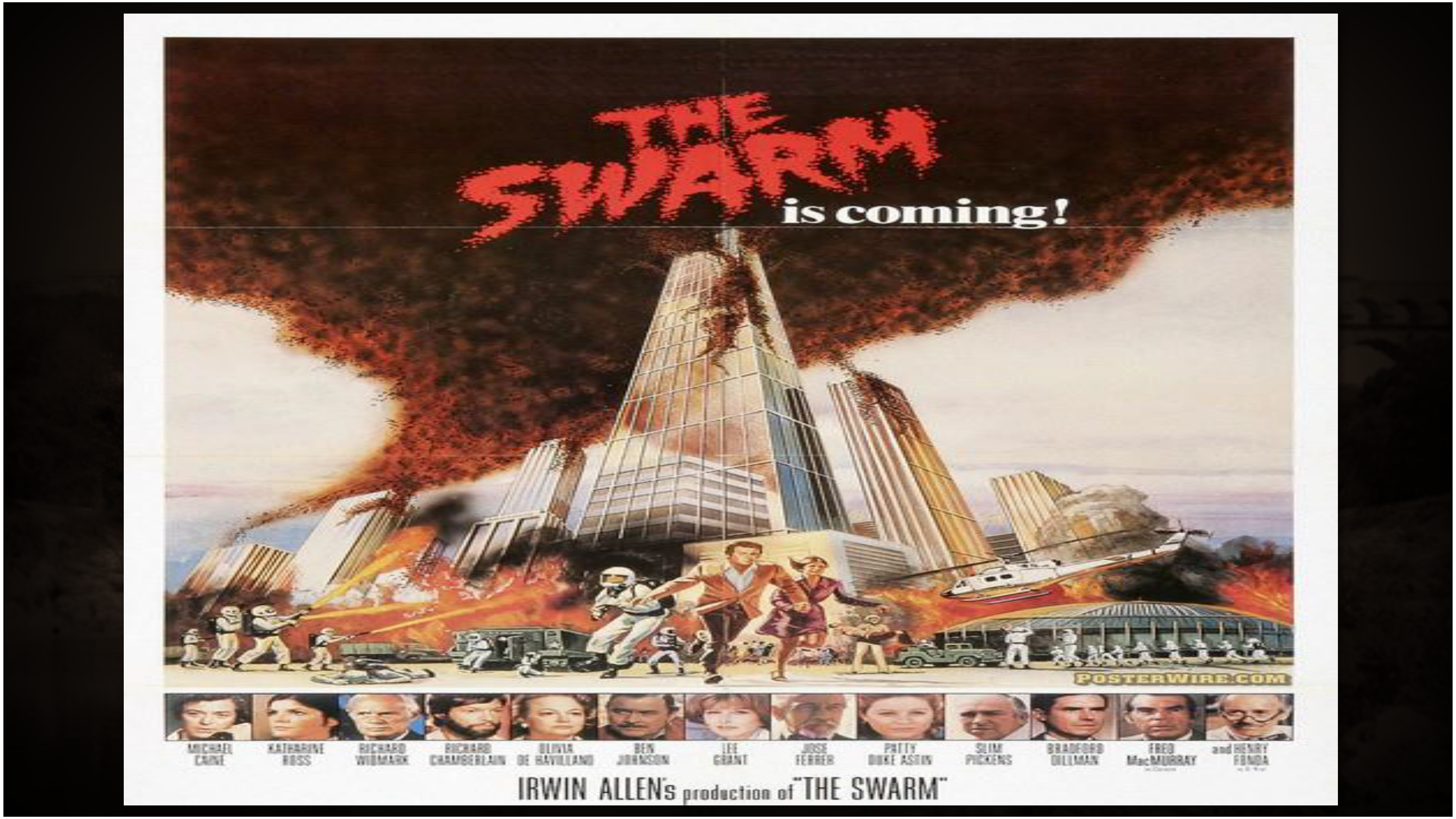


Power budget:
mWs to 1 mW

Vision 2025

- Integrated components will be approaching **molecular limits and/or may cover complete walls**
- Every object will be smart
- **The Ensemble is the Function!**
  - Function determined by availability of **sensing, actuation, connectivity, computation, storage and energy**
- Collaborating to present unifying experiences or to fulfill common goals

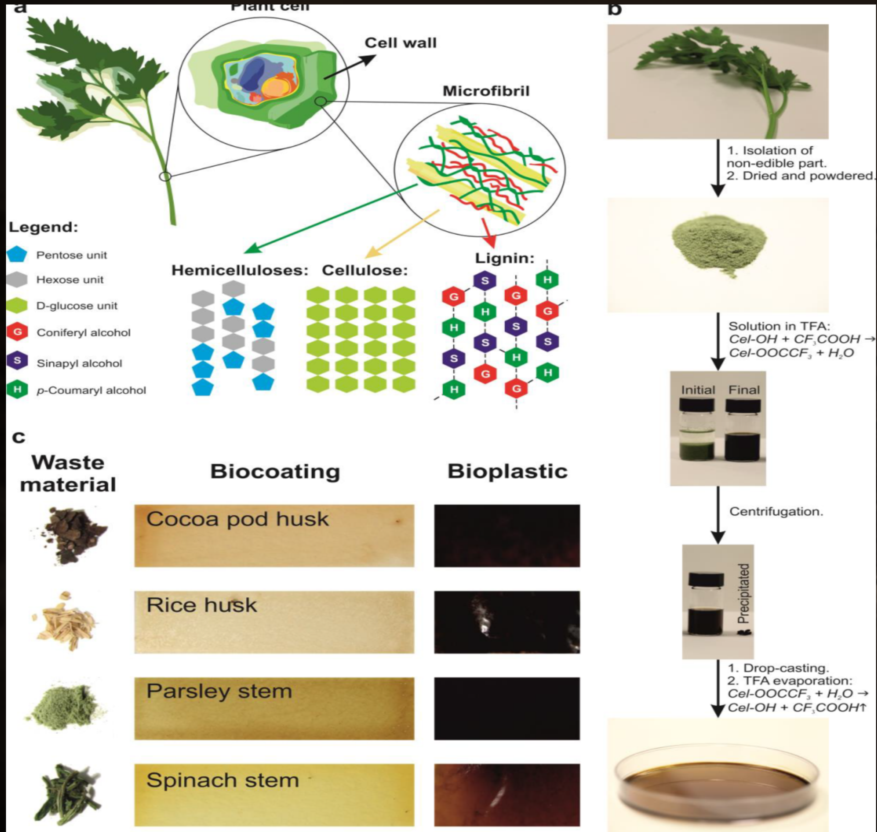
A humongous networked, distributed, adaptive, hierarchical, hybrid control problem


THE SWARM
is coming!
POSTERWIRE.COM
MICHAEL CAINE
KATHARINE ROSS
RICHARD WIDMARK
RICHARD CHAMBERLAIN
OLIVIA DE HAVILLAND
BEN JOHNSON
LEE GRANT
JOSE FERRER
PATTY DUKE ASTIN
SLIM PICKENS
BRADFORD DILLMAN
FRED MacMURRAY
and HENRY FONDA
IRWIN ALLEN's production of "THE SWARM"

The Problem Space (TerraSwarm)


ISTITUTO ITALIANO
DI TECNOLOGIA
Nano Materials:
The Fully Biodegradable Plastic

Fully Biodegradable Vegetable Plastics



World production:
260 Millions ton of petrol plastic /year

Biodegradation time > 1000 years

Vegetable waste from food industry:
26 Millions tons/year in Europe only!

Biodegradation time:
a few years in humid environment

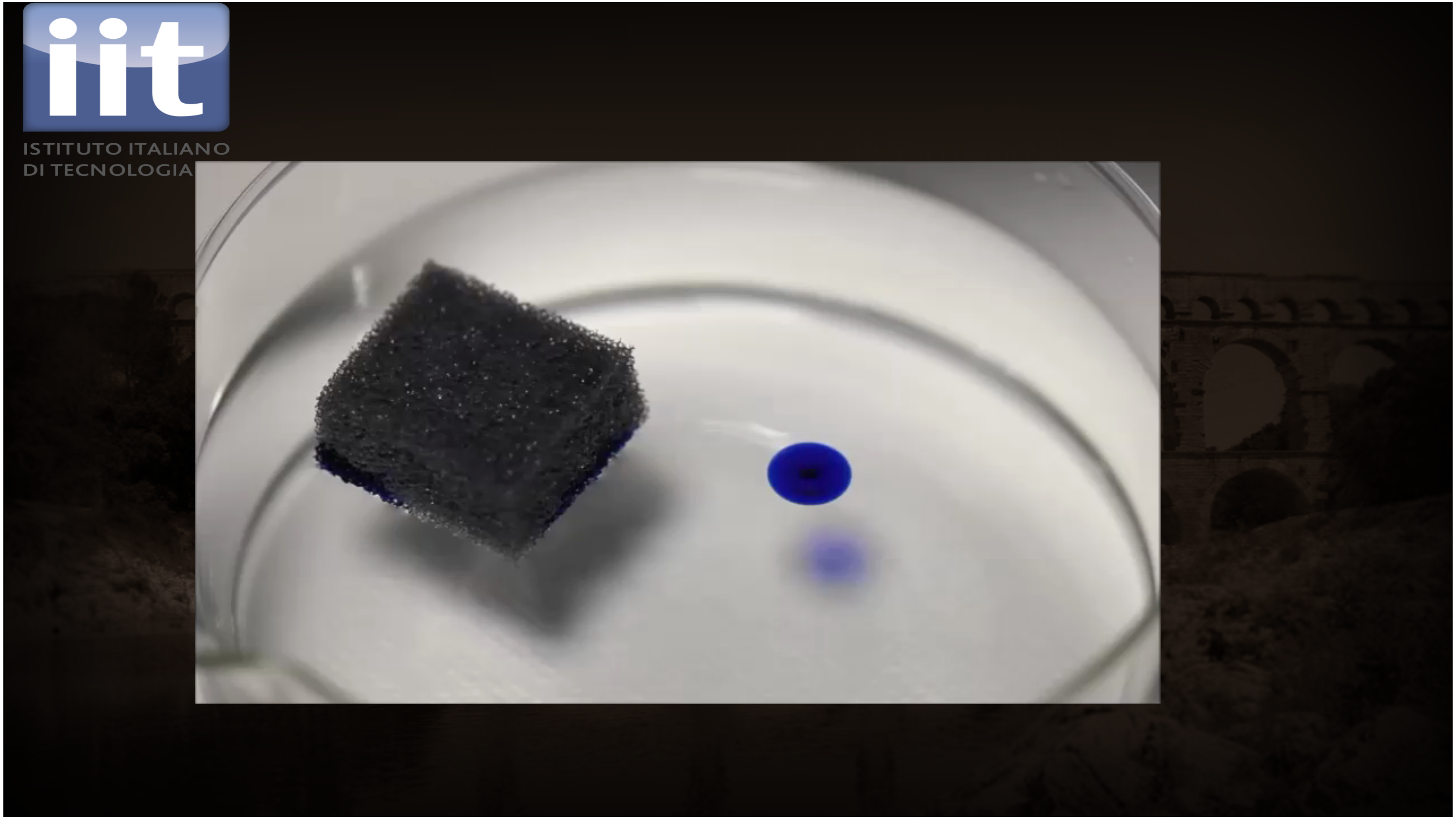
Biodegradable Vegetable Plastics

ISTITUTO ITALIANO
DI TECNOLOGIA

The Magic Sponge

Engineered Sponges

- The Magic Sponge
- Reversible hydrophobic/hydrophilic behavior by nanoparticle functionalization
- Engineered chemical affinity: oleophilic versus hydrophobic behavior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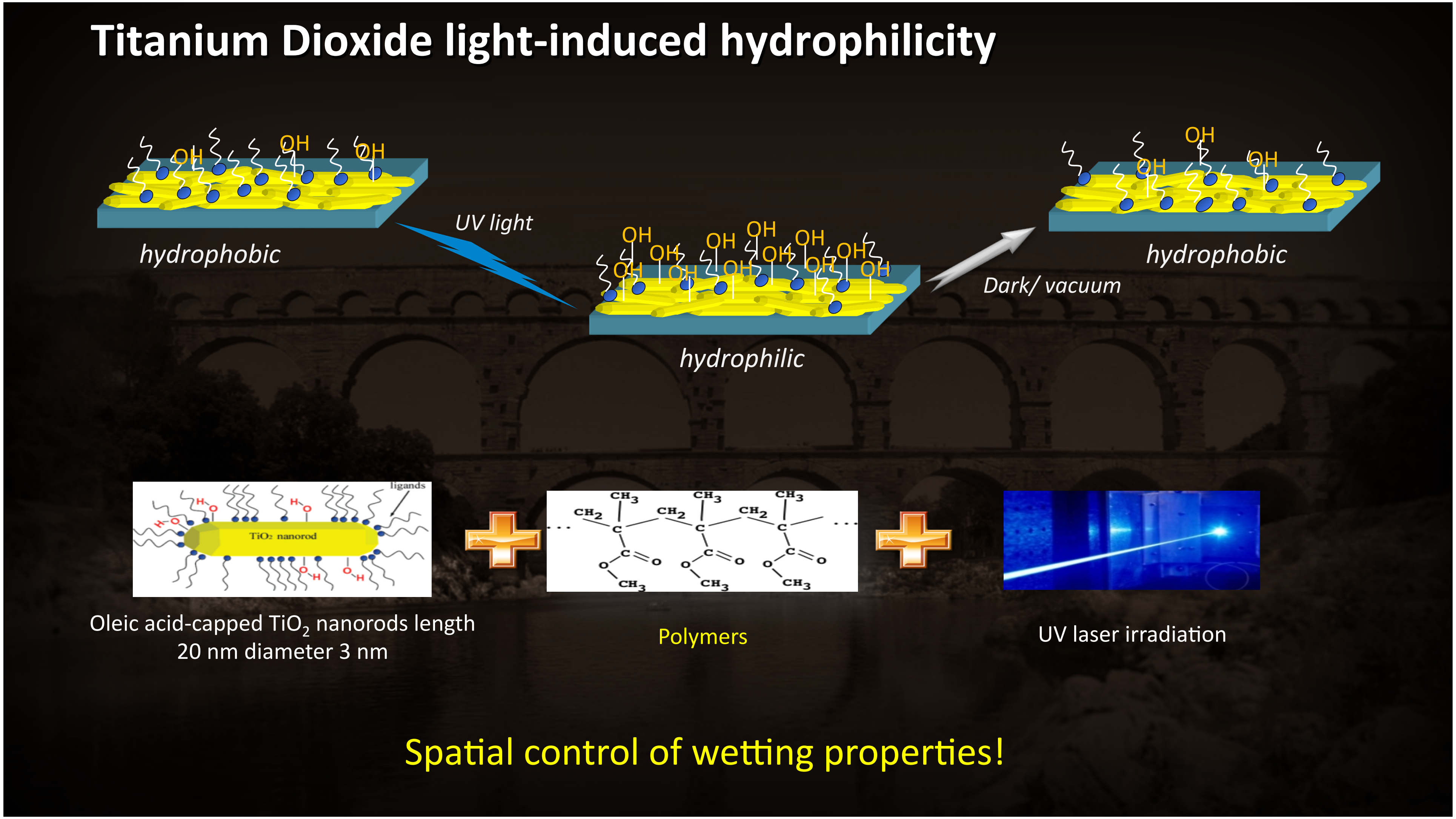
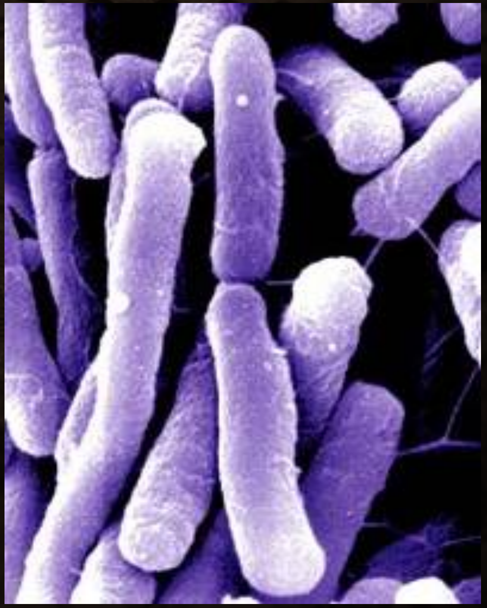
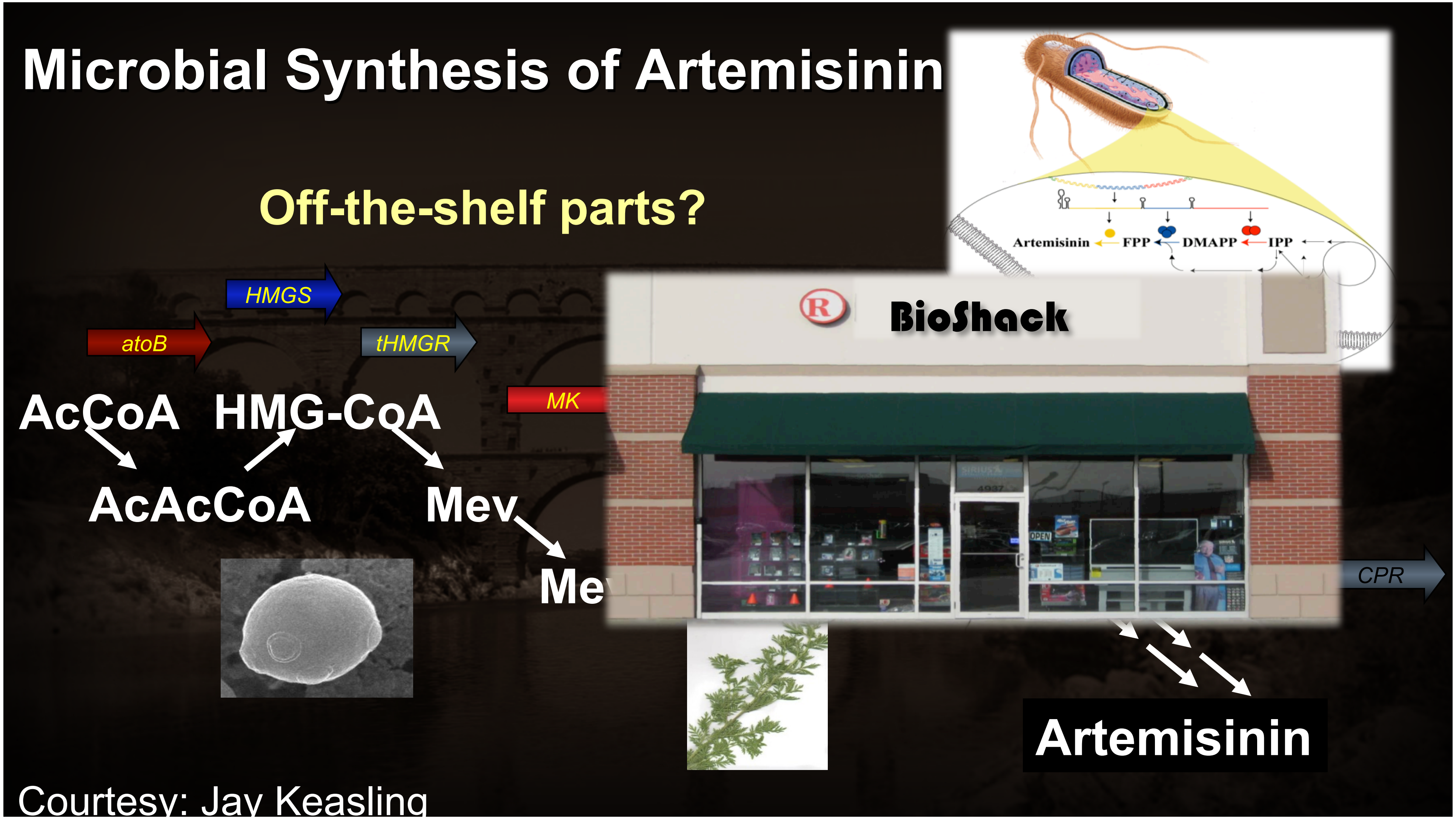

Titanium Dioxide light-induced hydrophilicity
OH
OH
OH
hydrophobic
UV light
hydrophilic
Dark/ vacuum
hydrophobic
ligands
TiO2 nanorod
Oleic acid-capped TiO2 nanorods length 20 nm diameter 3 nm
Polymers
UV laser irradiation
Spatial control of wetting properties!

Synthetic Biology

συν●θη●σισ *n.* 1.a. the combination of separate elements to form a coherent whole.



- Synthetic biology seeks, through understanding, to design biological systems and their components to address a host of problems that cannot be solved using naturally-occurring entities
- Enormous potential benefits to medicine, environmental remediation and renewable energy


Microbial Synthesis of Artemisinin
Off-the-shelf parts?
HMGS
atoB
tHMGR
MK
AcCoA
HMG-CoA
AcAcCoA
Mev
BioShack
Artemisinin
FPP
DMAPP
IPP
CPR
Artemisinin
Courtesy: Jay Keasling

Applications of Synthetic Biology

Energy Crop
- Water saving
- No fertilizer
- Doubled photosynthetic efficiency

Biodiesel and bio-jet fuel
- No compromise
- Fully compatible with existing infrastructure

Natural product drugs
- Capture all of the chemistry in nature
- Construct a microbe that can produce any natural product

Courtesy: Jay Keasling

Final Words of Wisdom

How About Education?

The Way Forward

- *Everything is Connected:* Society, Electronic and System Industry facing an array of complex problems from design to manufacturing involving complexity, power, reliability, re-configurability, integration….
- Complexity is growing more rapidly than ever seen
- Interactions among subsystems increasingly more difficult to predict
- Pre-existing systems put to work to provide new services
- *Need work at all levels: Methodology, Modeling, Tools, Algorithms*

- Deep collaboration among
  - Governments, industry, and research centers
  - Different Disciplines : Control, Communication, Computer Science, Electrical Engineering , Mechanical Engineering, Civil Engineering, Chemistry, Biology.....