Biodesic

hardware :: wetware :: mindware

The Bioeconomy, IP, and Synthetic Biology

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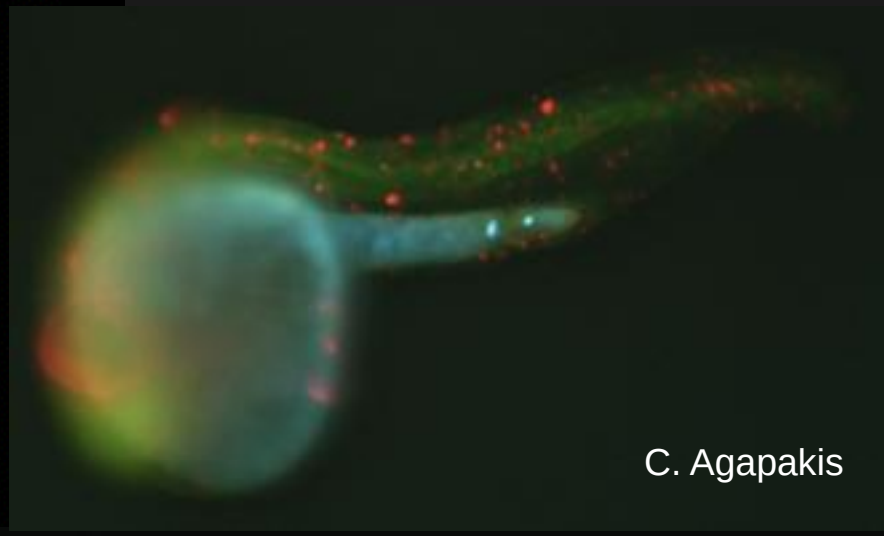
Rob Carlson
Biodesic
Seattle, WA

www.biodesic.com
@rob_carlson
rob@biodesic.com
blog: www.synthesis.cc

The Past and ~~Future~~ Present of Biological Technologies

hotosynthetic Sea Slug
(*Elysia chlorotica*)
Evolved ~100 Myr BCE



C. Agapakis

Photosynthetic Fish
(*Danio rerio*)
Engineered 2010 +5 (?) yrs
Pam Silver, Harvard Univ.

PNAS

I. Bioeconomy

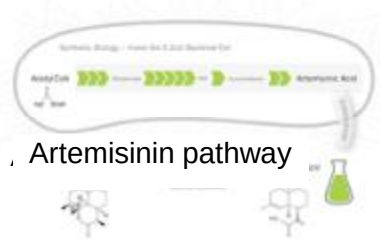
A Hierarchy of Engineering and Economic Complexities

Claudia Cadillo
Transplant Recipient

Multiple Cells: Control of growth and differentiation; products are cells and structures that cells make (Tissues, Organs, Animals, Houses). **3D Printing?**

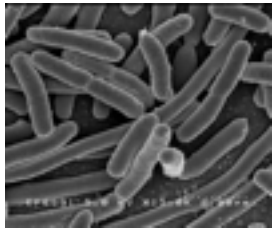
J.C. Venter

Synthetic Single Cells: Looks initially like Metabolic Engineering; products are chemicals and biologicals made by cells.



Artemisinin pathway

Multiple Genes in a Single Cell Type: Metabolic Engineering: Fuels, Plastics, Terpenoids for Drugs, Flavors, and Fragrances. **RFS.**



Expression in *E. coli*

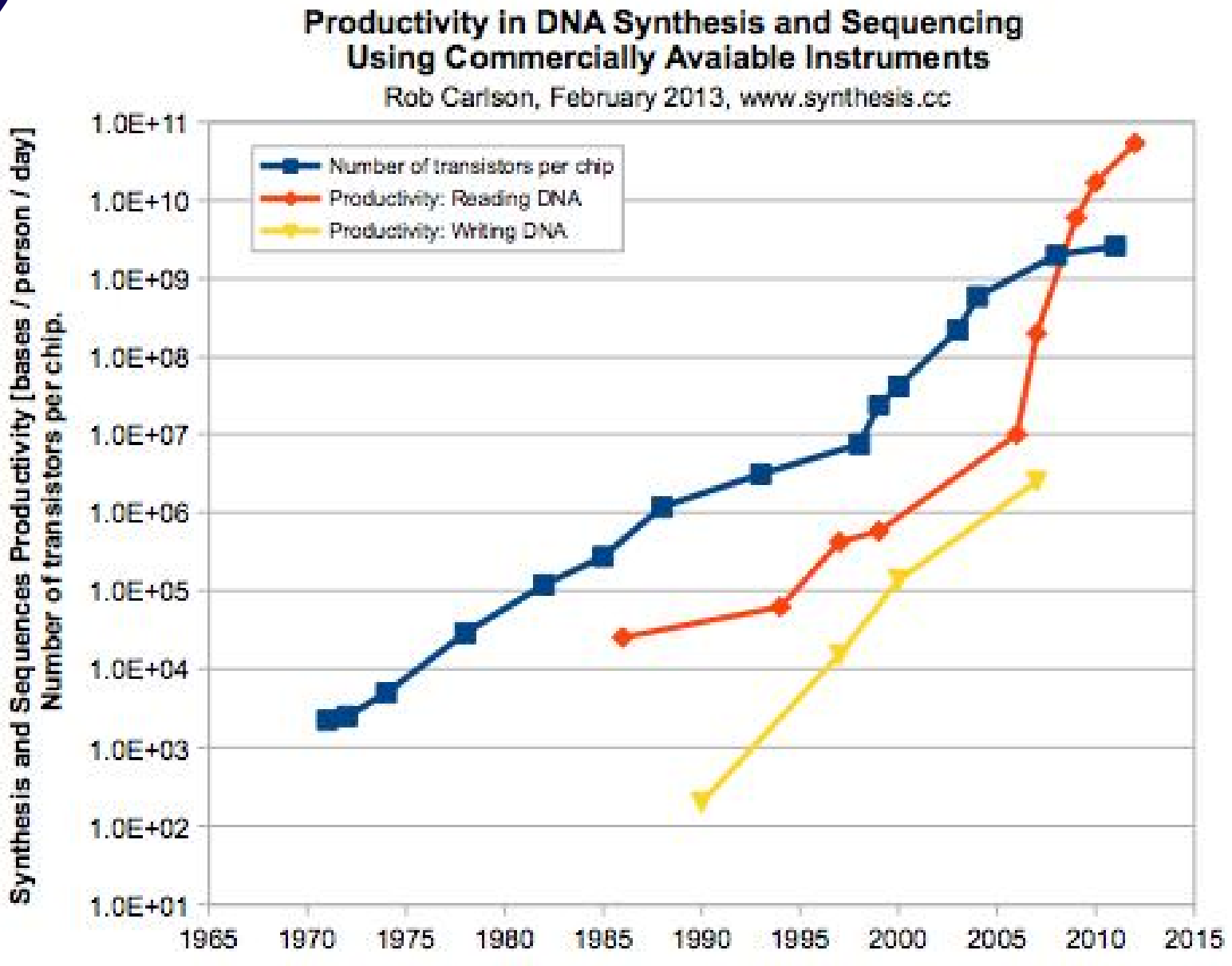
"Single" Gene in a "Single" Cell: Recombinant Proteins: Laundry Enzymes, HGH, EPO.

US GDP

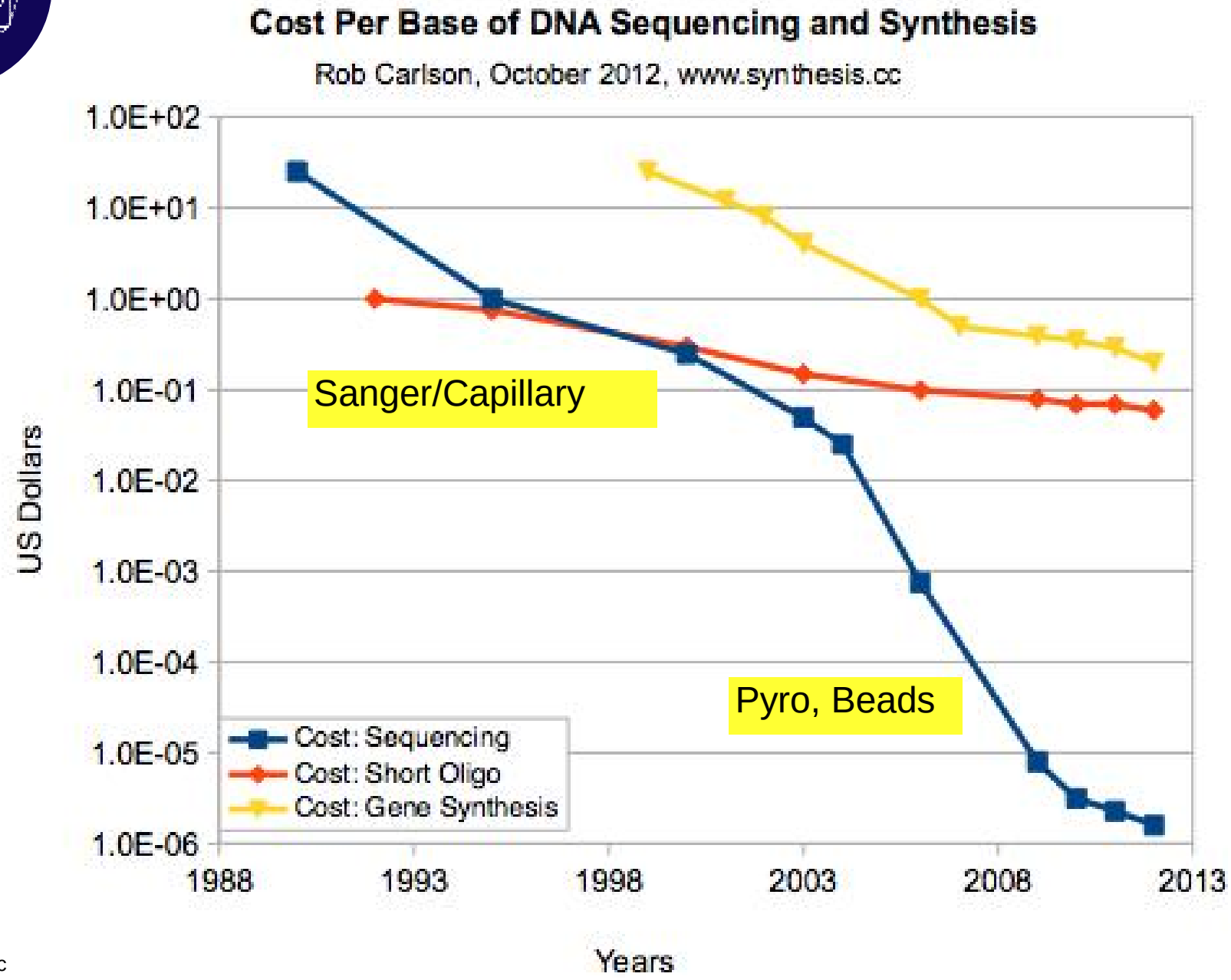
2010 > 2%

1978 ~ 0%

Enabling Technologies Are Improving Rapidly

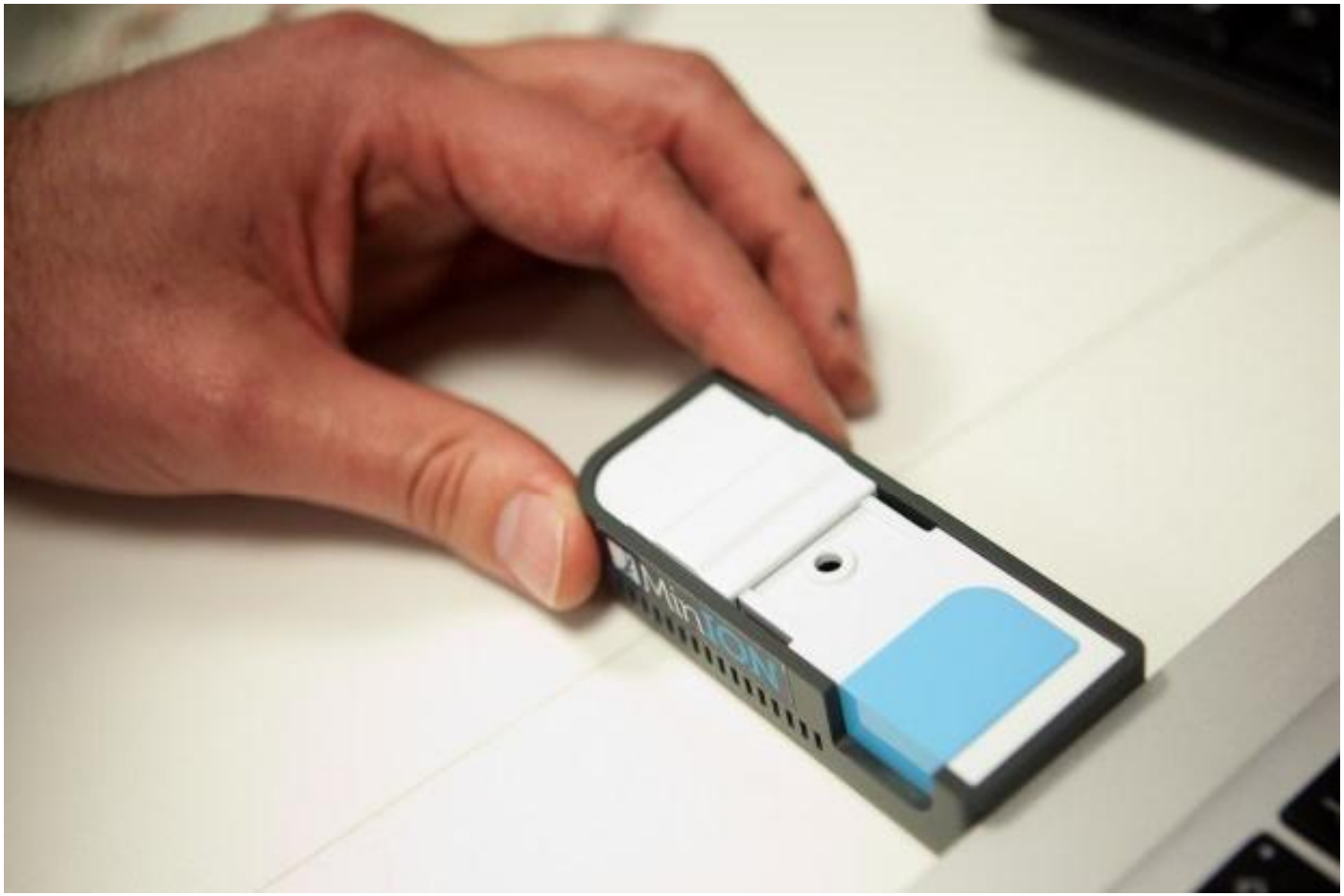


Cost c. 2012



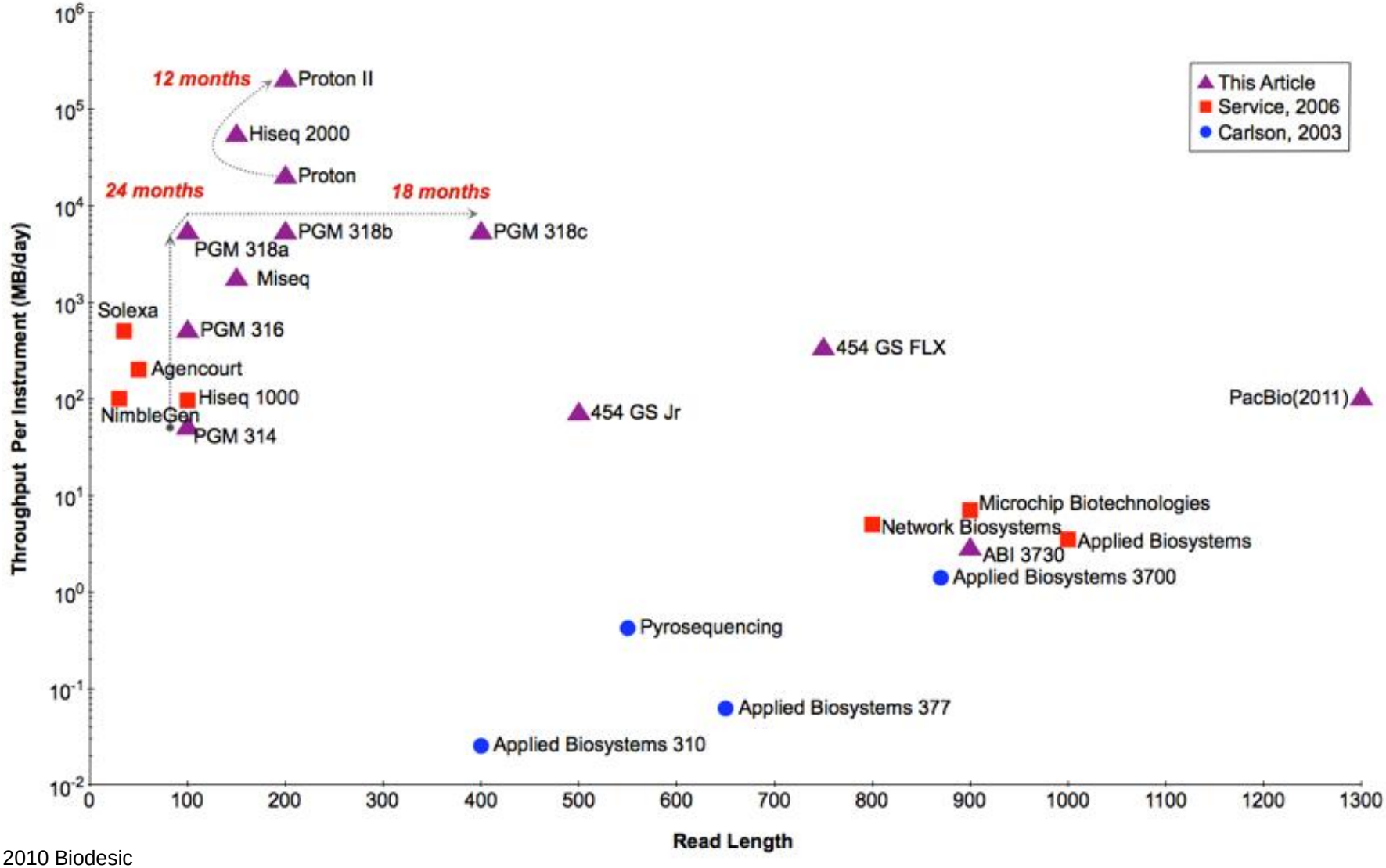
II. Competition

The Future?

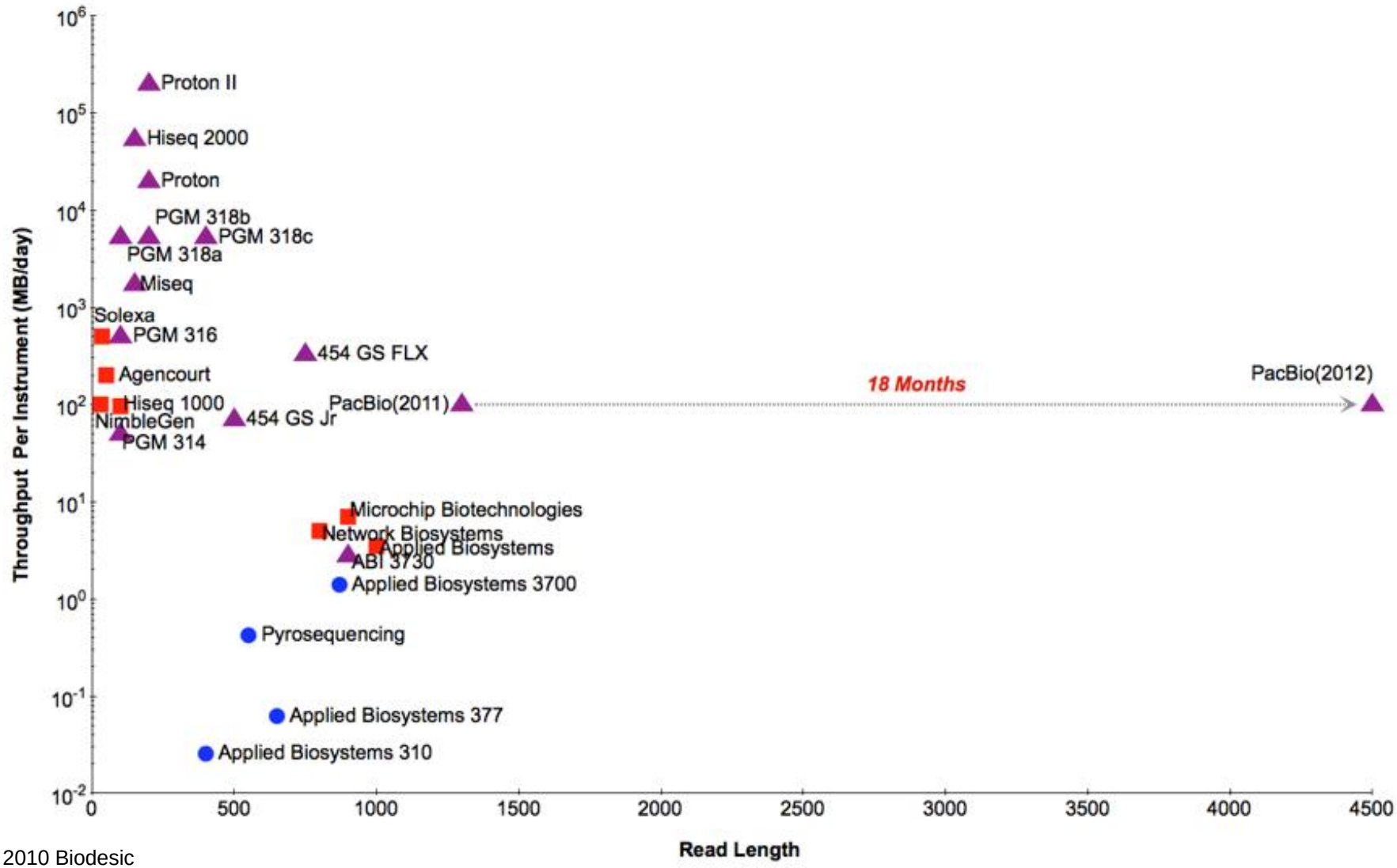


Oxford Nanopore

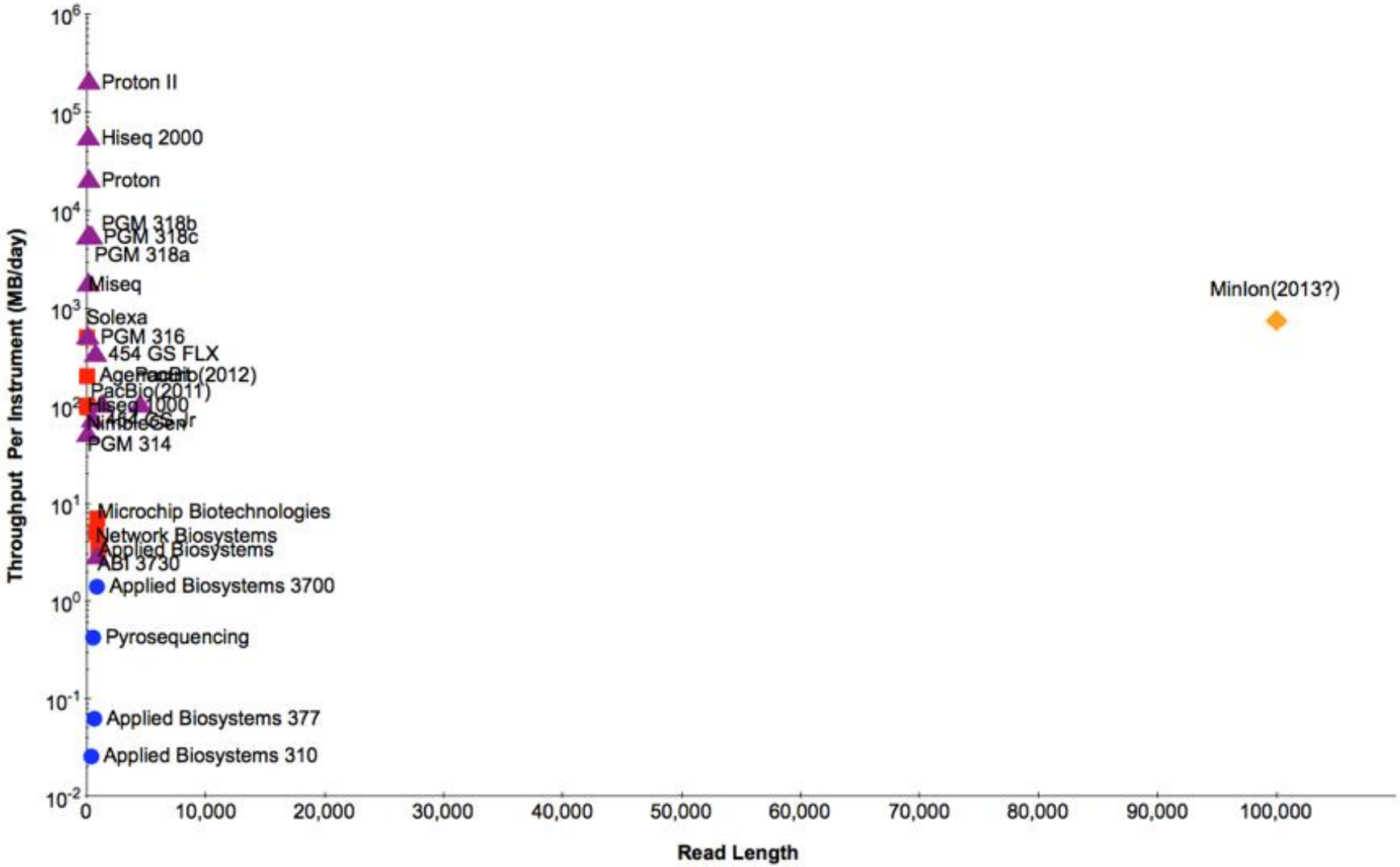
Market Driven Performance Improvements 1



Market Driven Performance Improvements 2



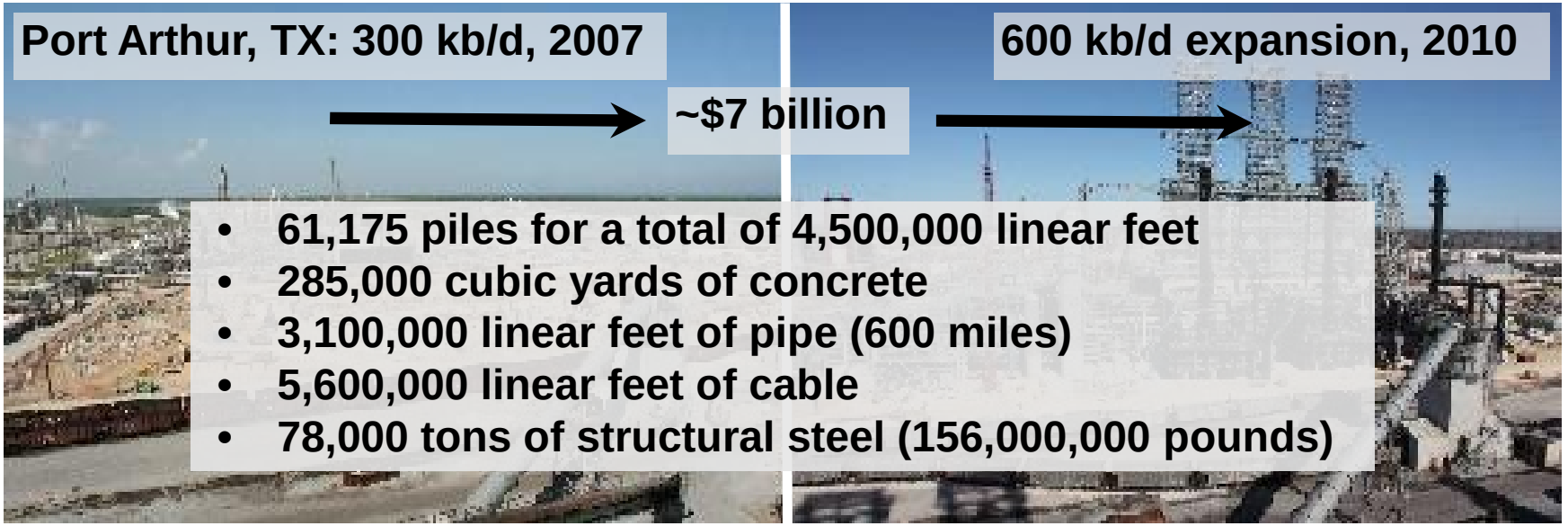
Market Driven Performance Improvements 3



III. Scale

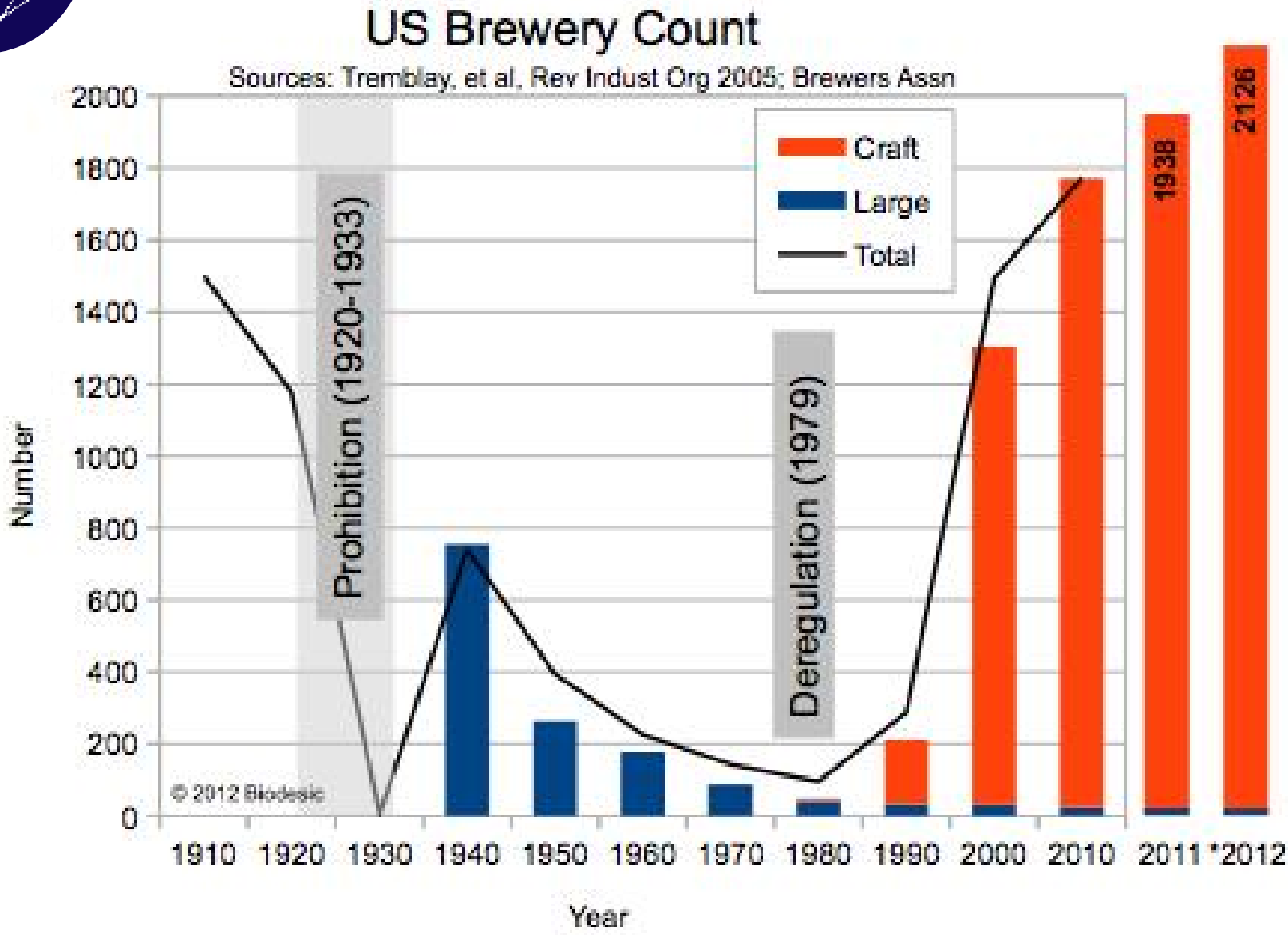
Costs of Scaling Up

Industrial Chemistry



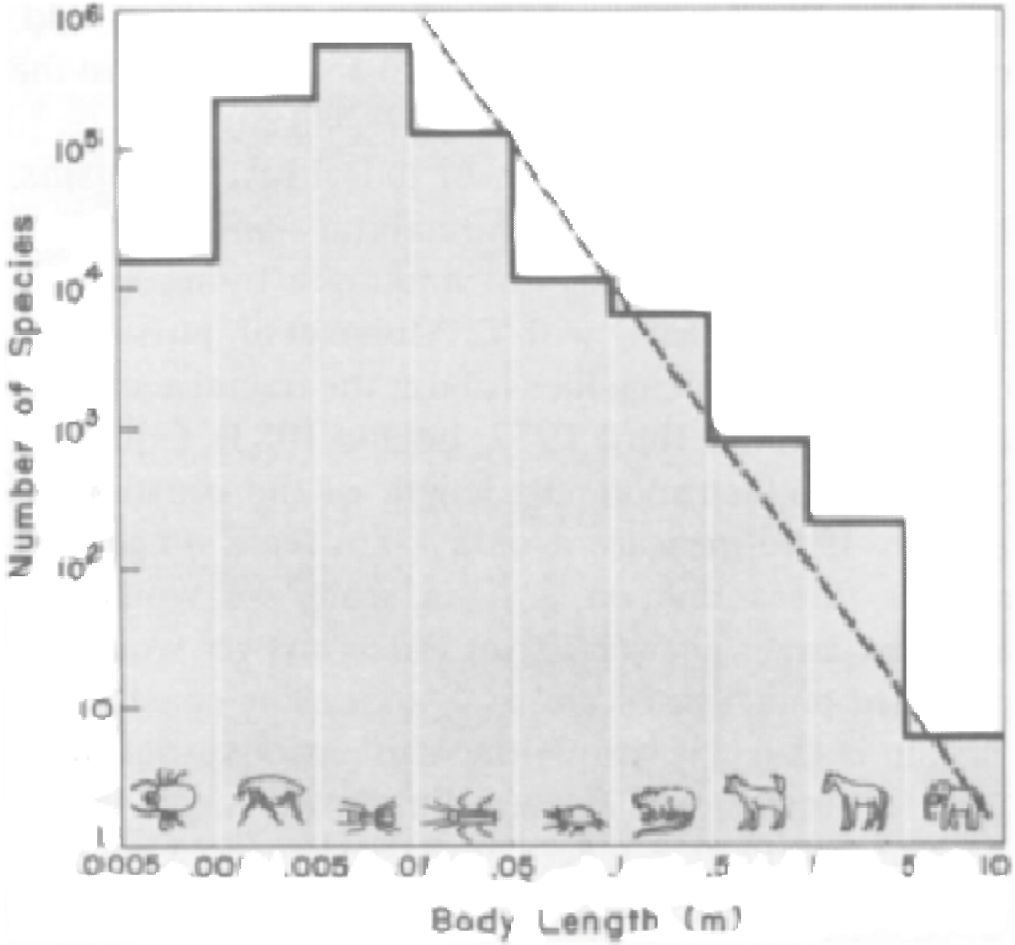
Shell

Micro-Brewing the Bioeconomy



Just what is a “Biofactory”?

If means of production starts to lean heavily on biology, do individual production lines start to look more like biology? Does the economy start to look more like an ecology?



Most organisms are small.

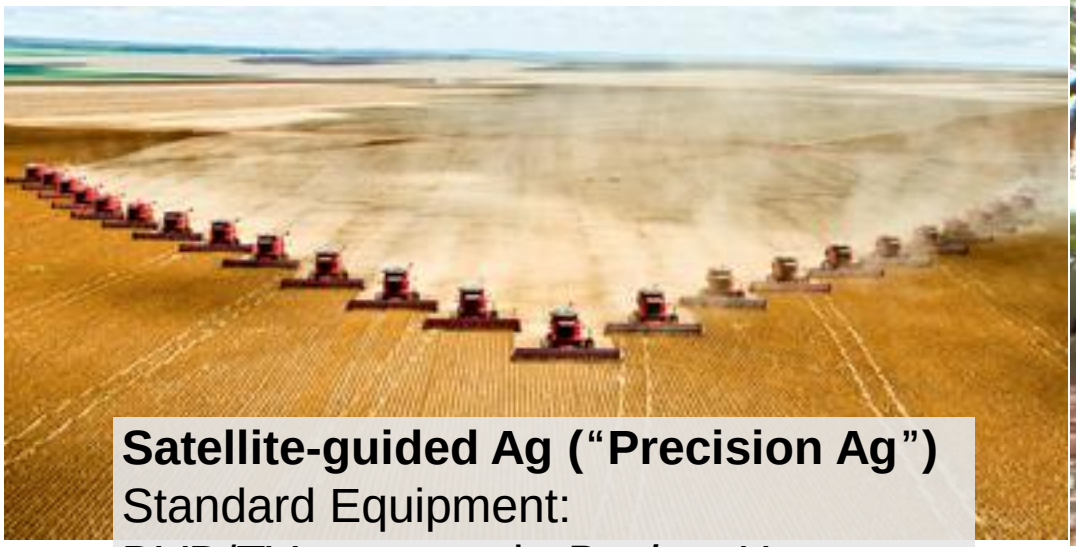
Animals larger than ~1m are very rare.

Adding microbes to the plot would swamp animals.

Material transport occurs via networks, air/water, bodies of animals themselves.

Robert M. May, “The Search for Patterns in the Balance of Nature: Advances and Retreats”, Ecology, Vol. 67, No. 5 (Oct., 1986), pp. 1116-1126

Mobile Biofactories: How Far Can This Go?



Satellite-guided Ag ("Precision Ag")
Standard Equipment:
DVD/TV to entertain *Backup* Human Guidance System

Big Dog, Boston Dynamics

Vegetarian robots

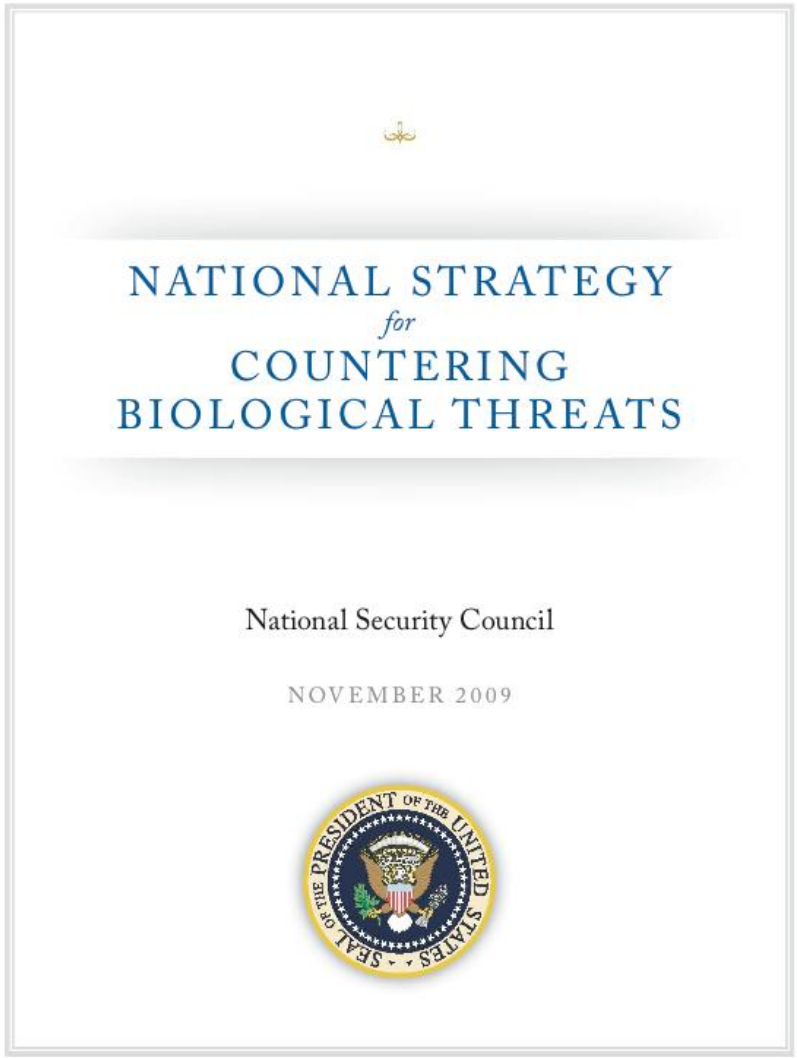
Munching machines

Robots that forage for fuel and run on steam power

May 10th 2010 | From *The Economist* online

IV. Security

President of the United States: "Garage biology is good."



"*The beneficial nature of life science research is reflected in the widespread manner in which it occurs. From cutting-edge academic institutes, to industrial research centers,* **to private laboratories in basements and garages, progress is increasingly driven by innovation and open access to the insights and materials needed to advance individual initiatives.**"

Unexpected Impacts of Policy on Proliferation

Cocaine:

http://blog.wired.com/27bstroke6/2009/01/new-law-harpoon.html

Restricting access to commodities can create dedicated technology development efforts to meet supply:

- "Narco-subs"
  - Cost of Construction:$.5-2 million.
  - Cargo: ~$1 billion in cocaine.
  - Now moved on to fully submersible

Meth:

"…Marked success in decreasing domestic methamphetamine production through law enforcement pressure and strong precursor chemical sales restrictions has enabled Mexican DTOs to rapidly expand their control over methamphetamine distribution."

http://www.usdoj.gov/dea/concern/18862/meth.htm

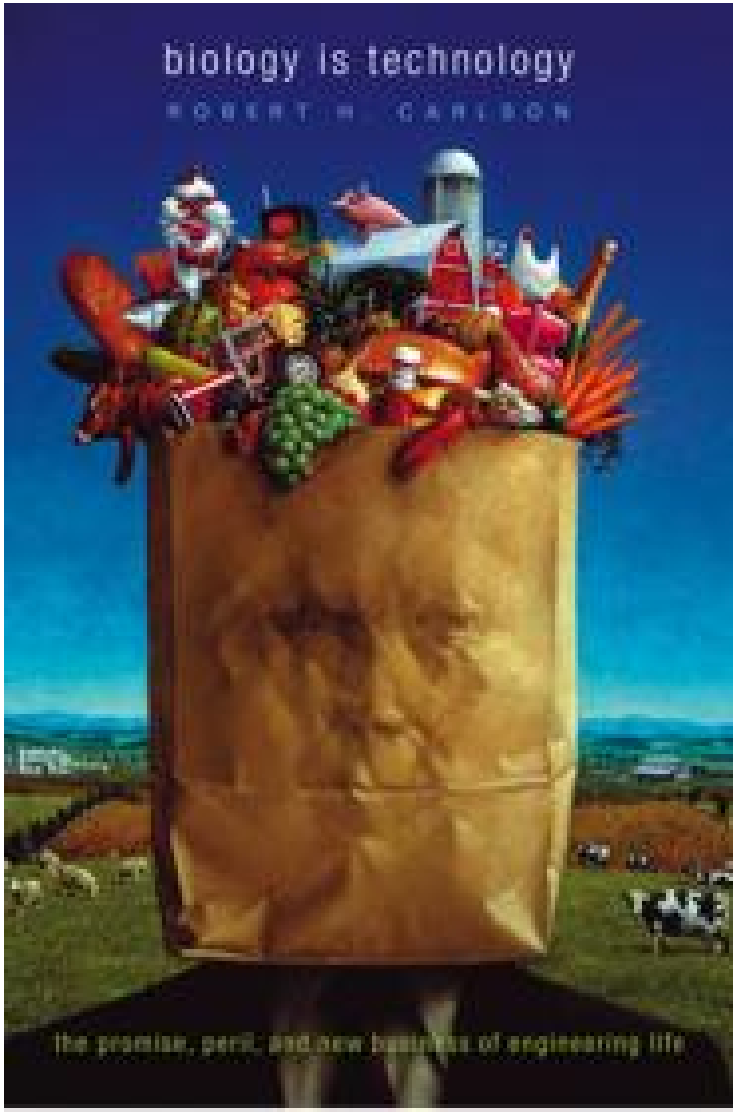
Increased enforcement efforts have created a larger, blacker market that is *"[M]ore difficult for local law enforcement agencies to identify, investigate, and dismantle because [it is] typically much more organized and experienced than local independent producers and distributors."*

"Methamphetamine Strategic Findings":
http://www.usdoj.gov/dea/concern/18862

Piracy

In large markets,
with democratized production technology,
restrictions on access to those markets and technology
incentivize piracy and create insecurity.

E.g. printing, software, music, favela innovation, System D (from Lagos to Brazil to cloning NEC), legal highs/bath salts, post-independence US economy (*Smuggler Nation*, Peter Andreas).



Thank You

Biology is Technology:
The Promise, Peril, and New Business of Engineering Life
Robert Carlson
Harvard University Press, 2010.

PROSE Award for Best Science and Technology Book of 2010

Best Books of 2010, *The Economist*

Best Books of 2010, *ForeignPolicy.com*

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