Managing environmental, health and security risks related to the development of synthetic biology and its applications

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Storyline

- Overview of work Woodrow Wilson Center and MIT's Program on Emerging Technologies have been conducting on upstream environmental risk assessment
  - Beyond Containment
  - Comprehensive Environmental Assessment
  - Managing Uncertainty
  - Data needs and testing methods
- iGEM Safety Screening
- DIYBIO biosafety/biosecurity efforts
- Closing thoughts

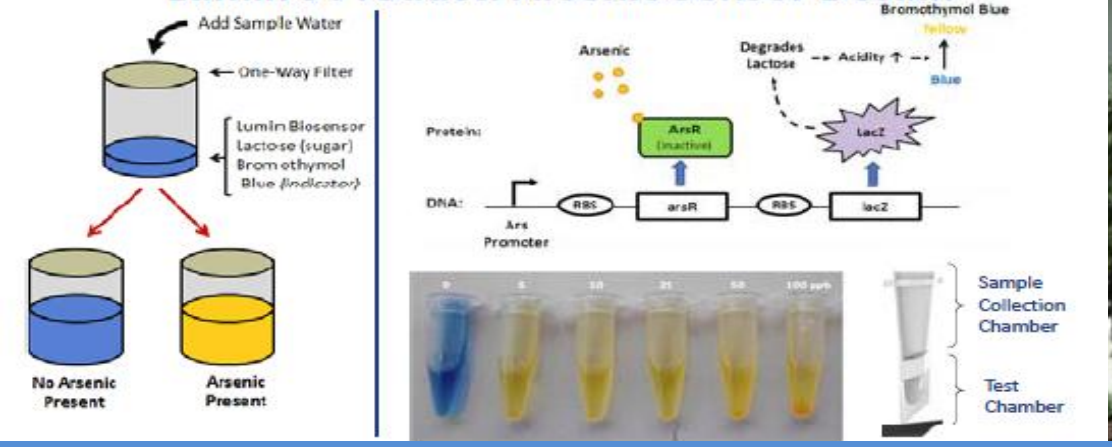
Who, What, and Why

- Who: Synthetic biologist, industry, policy makers, NGOs, environmental microbiologists, ecologists, insurers, lawyers
- What: Series of workshops evaluating specific synthetic biology applications near commercialization or field trial level
  - Incidental release expected or deliberate release planned
- Why: assess risks, redesign applications, develop tests and evaluate proactive risk management processes

Beyond Containment: Assessing, Testing and Demonstrating Safety on Release of SynBio Devices and Chassis

- Lumin Biosensor – iGEM project
- Chassis design – rE.coli
- Tagging sources of uncertainty
- End of life issues
  - What the product is designed for
  - How people might actually use it

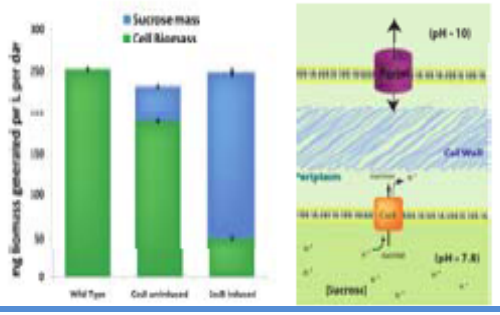
Lumin's Product: Arsenic Sensor Design



Gautam Mukunda
Lumin, MIT, HBS

Sucrose-producing Cyanobacteria

Because of large surface area required, cyanobacteria are often grown in outdoor environments for economical reasons. Genetic modification is also required for high yields. These needs present a unique issue for ecological containment.



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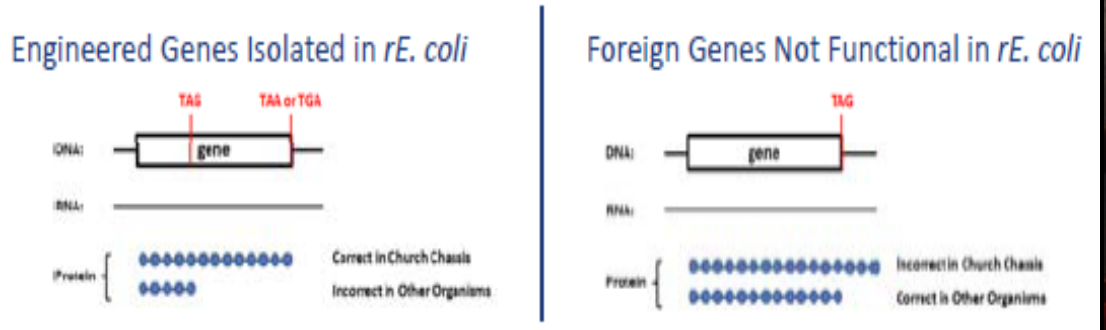
rE. coli Chassis

Removal of TAG stop codon limits horizontal gene transfer



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Comprehensive Environmental Assessment

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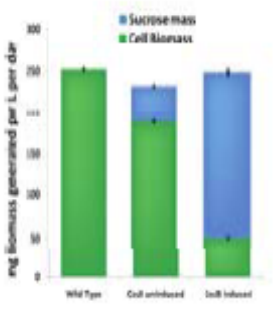

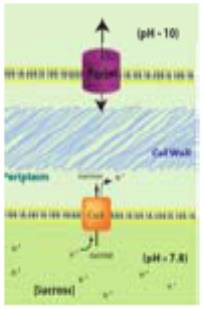

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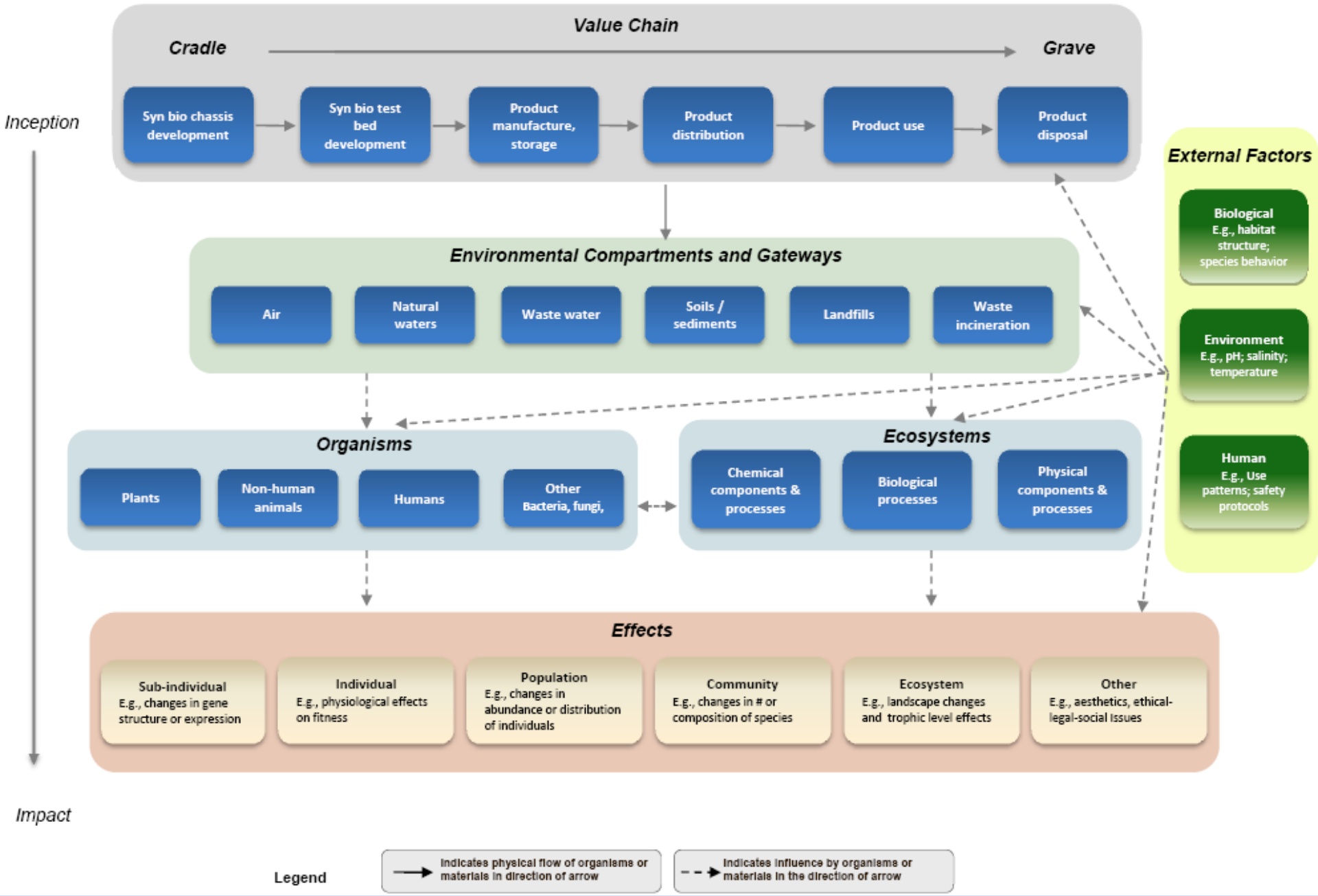
Raceways and Sluices

Plastic Bags

Surface Ponds

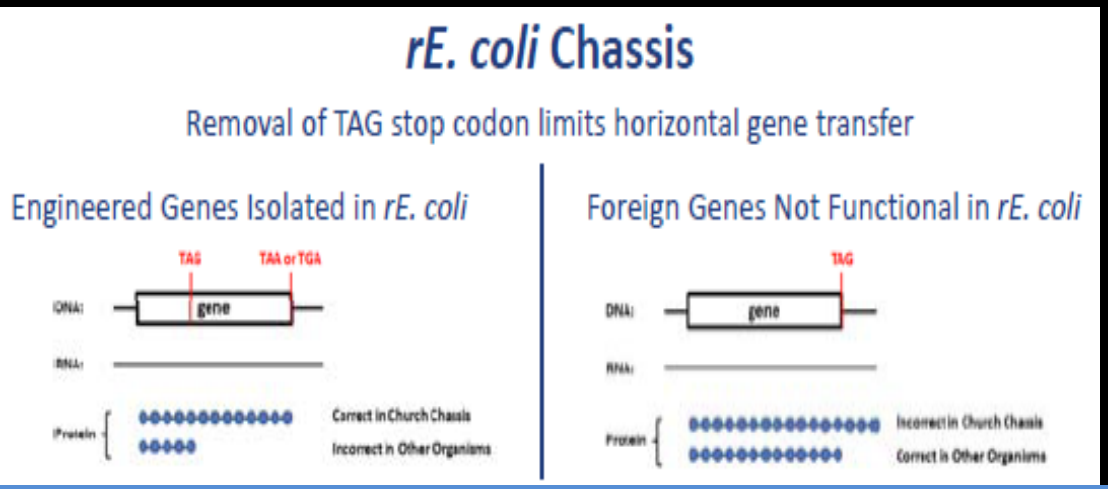
Comprehensive Environmental Assessment (CEA) Framework



Comprehensive Environmental Assessment

- Rates of evolution and changes in functionality
- Survival and persistence of the organism
- Fate and transport of functional genetic material
- Physiological differences and functionality between the wild and novel organism
- Probabilistic modeling of gene transfer

Managing Uncertainty: How to Assess, Test and Demonstrate Safety for Synthetic Biology Applications



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A solar saltern, whose occupants benefit from archaea-to-bacteria transfer of salinity adaptations

Pea aphids, whose distinctive coloration is believed to result from fungus-to-animal gene transfer

In this bacteria-to-animal transfer, a nematode parasitizes plants using genes from parasitic bacteria.

Managing Uncertainty: How to Assess, Test and Demonstrate Safety for Synthetic Biology Applications

- What's the problem with gene transfer?
- Agent-based models
  - Do new models need to be developed
- Persistence in the environment
- Time lag questions
  - 1yr, 5yrs, 20yrs?
- What is the impact of genes on community
  - What is the community
- Instrumentation and Metrology

Data needs and testing methods for assessing the safety of a field release of synthetically designed algae for biofuel production

- Initiated by the U.S. EPA based on 3 previous workshops
- Included 4 leading synthetic biology companies
  - Synthetic Genomics
  - Algenol
  - Sapphire Energy
  - Agilent Technologies
- Determine the data needs and testing methods for the environmental release of synthetically designed algae
- Assess the ecological effects and risks of synthetic organisms

2004

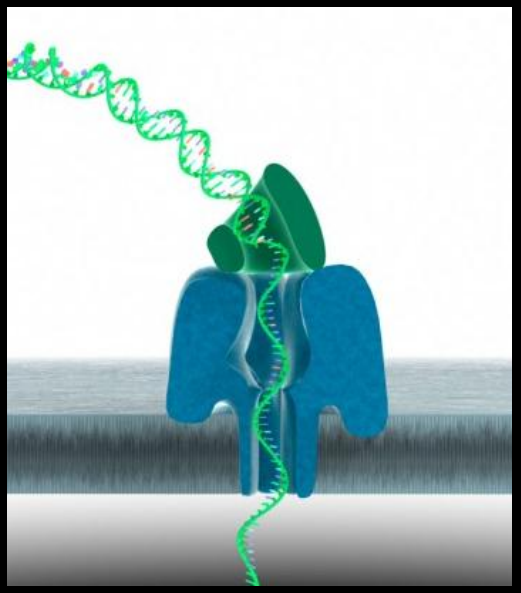
2010

Do It Yourself Biology

- DIYbio.org was founded in April 2008 in order to help organize the efforts of amateur biologists, citizen scientists, and other non-traditional practitioners of biology, worldwide.
- DIYbio.org is an organization dedicated to making biology an accessible pursuit for citizen scientists, amateur biologists and biological engineers who value openness and safety.

Data Disruption

Nano-Bio-Info Device



$900 USB-powered DNA sequencer

http://www.gizmag.com/minion-disposable-dna-sequencer/21513/?utm_source=Gizmag+Subscribers&utm_campaign=6d6aea9b18-UA-2235364&utm_medium=email

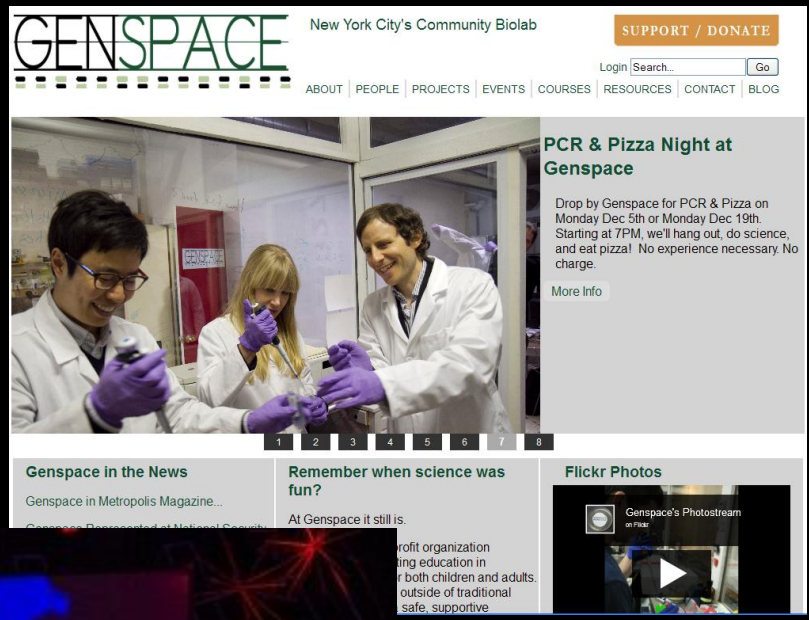
Personalized Medicine

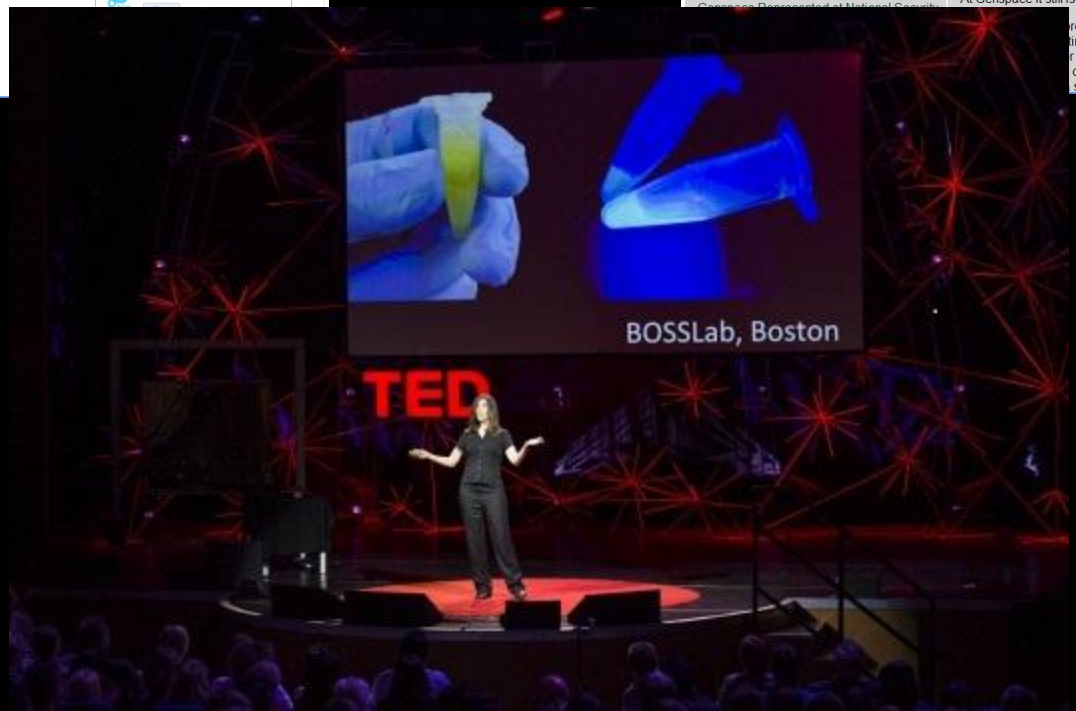
Sanofi's iBGStar blood glucose meter (now with full FDA approval). The iBGStar costs $99.95 from the Apple Store and is compatible with the 2nd, 3rd and 4th generation iPod Touch as well as the iPhone 3G, 3GS, 4 and 4S.

EyeNetra - uses a smartphone and a $2 plastic lens attachment for delivering mobile eye exams

One of the first major stories about the DIYBIO movement was when Kai Aull developed a genetic test for the hereditary disorder hemochromatosis.

Community Labs – Convergence within the Community





Amateurs Are New Fe

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By CARL ZIMMER
Published: March 5, 2012

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Hacking the President's DNA

The U.S. government is surreptitiously collecting the DNA of world leaders, and is reportedly protecting that of Barack Obama. Decoded, these genetic blueprints could provide compromising information. In the not-too-distant future, they may provide something more as well—the basis for the creation of personalized bioweapons that could take down a president and leave no trace.

By ANDREW HESSEL, MARC GOODMAN and STEVEN KOTLER +1 81 Share 75 Recommend 2.2k

s of the Mockingjay

lly popular these days,
the hugely popular movie
t's the mockingjay, a cross
gineered spy bird called a

n "The Hunger Games"
n a fictional future in
gers are forced to hunt
another in annual
s designed to entertain
s a highly controlled
The mockingjay first
symbol, when Katniss Everdeen
n that depicts the bird. Mockingj
t the birds, have spread to the rea

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Katniss explains in the first boo
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ARTS LIFE HEALTH TECH

along with DIY

instructions

BY MARGARET MUNRO, POSTMEDIA NEWS MAY 3, 2012

New Funding Paradigms

- Traditional funding agencies and their “silos” will be reluctant to direct an ever shrinking research budget to areas outside of their traditional funding regimes
- Develop a funding structure which cross advertises calls for proposals
- Set up a new pool of resources that is designated for convergence
- Funding agencies should develop metrics and procedures in order to allow actors outside the traditional academic or business communities to apply for and receive grants.

New Education Paradigm

- Traditional silos need to be broken down
  - Campus maps need to be re-envisioned
- Create a bridge between disciplines
- Incentivize multi-disciplinary collaboration

Shift to Massively Distributed, Integrated Systems

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Things, Machines, Ideas....

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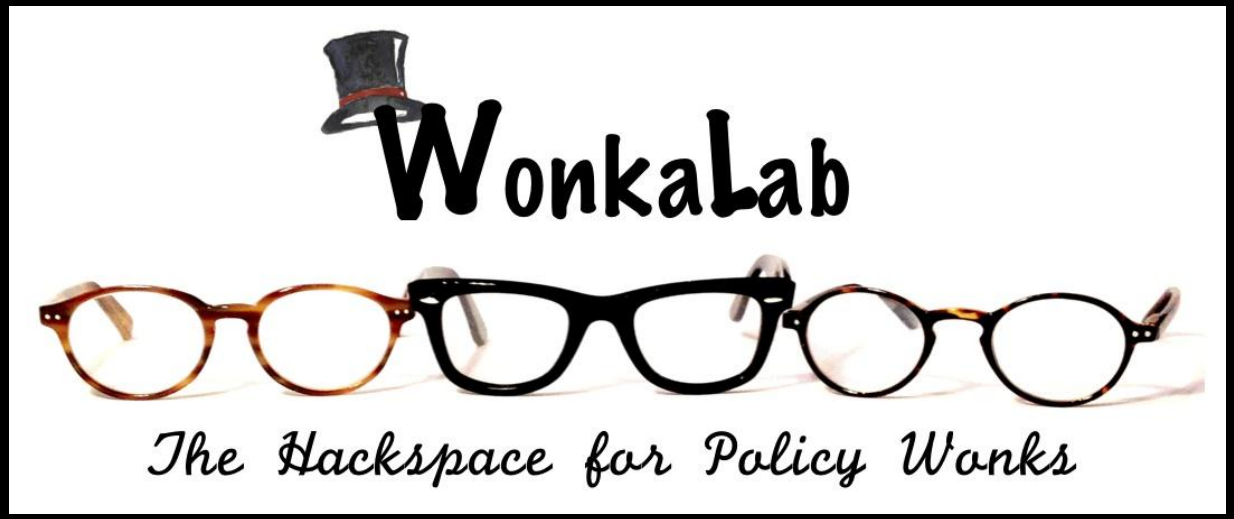
Threat or Opportunity - or Both?



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Synthetic BIOLOGY PROJECT

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