WORKSHOP ON THE RESEARCH AGENDA IN THE SOCIETAL ASPECTS OF SYNTHETIC BIOLOGY

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Arizona State University

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WHY SYNTHETIC BIOLOGY?

Synthetic Biology demarcated as emerging technology because:

- Diverse and dynamic nature
- Rapid growth
- Uncertainty but high stakes of its outcomes
- Different values operative in its assessment

“POLITICS OF NOVELTY”

“…the decision about the novelty of nanotechnology, or synthetic biology, or geoengineering, can be settled by neither the nature nor essence of those technologies, nor by the definition nor reference to the concept of novelty itself. Rather it needs to be settled – if indeed it can be settled – by a political process that references context and the particular aspects of the novelty at stake – its purposes” (Guston 2013).

THE WORKSHOP: 4-6 NOVEMBER 2014

PIs: Guston (ASU), Brian (ASU), Murray (Caltech)

115 people…

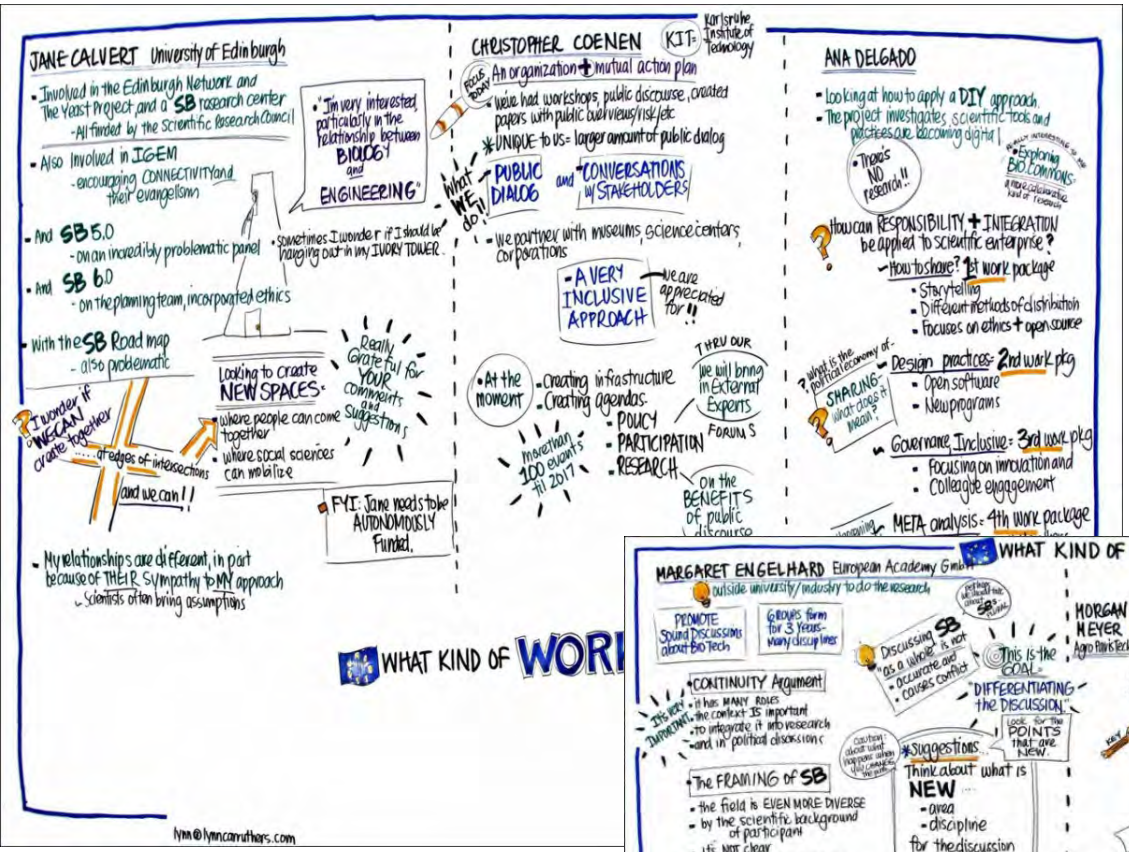
- US and EU
- Societal and S&E
- SynBio and Other ET
- Across career status
- Across sectors
- Across intellectual approaches

OPENING PLENARY

DINNER PLENARY

WEDNESDAY PLENARIES: US

WEDNESDAY PLENARIES: EU

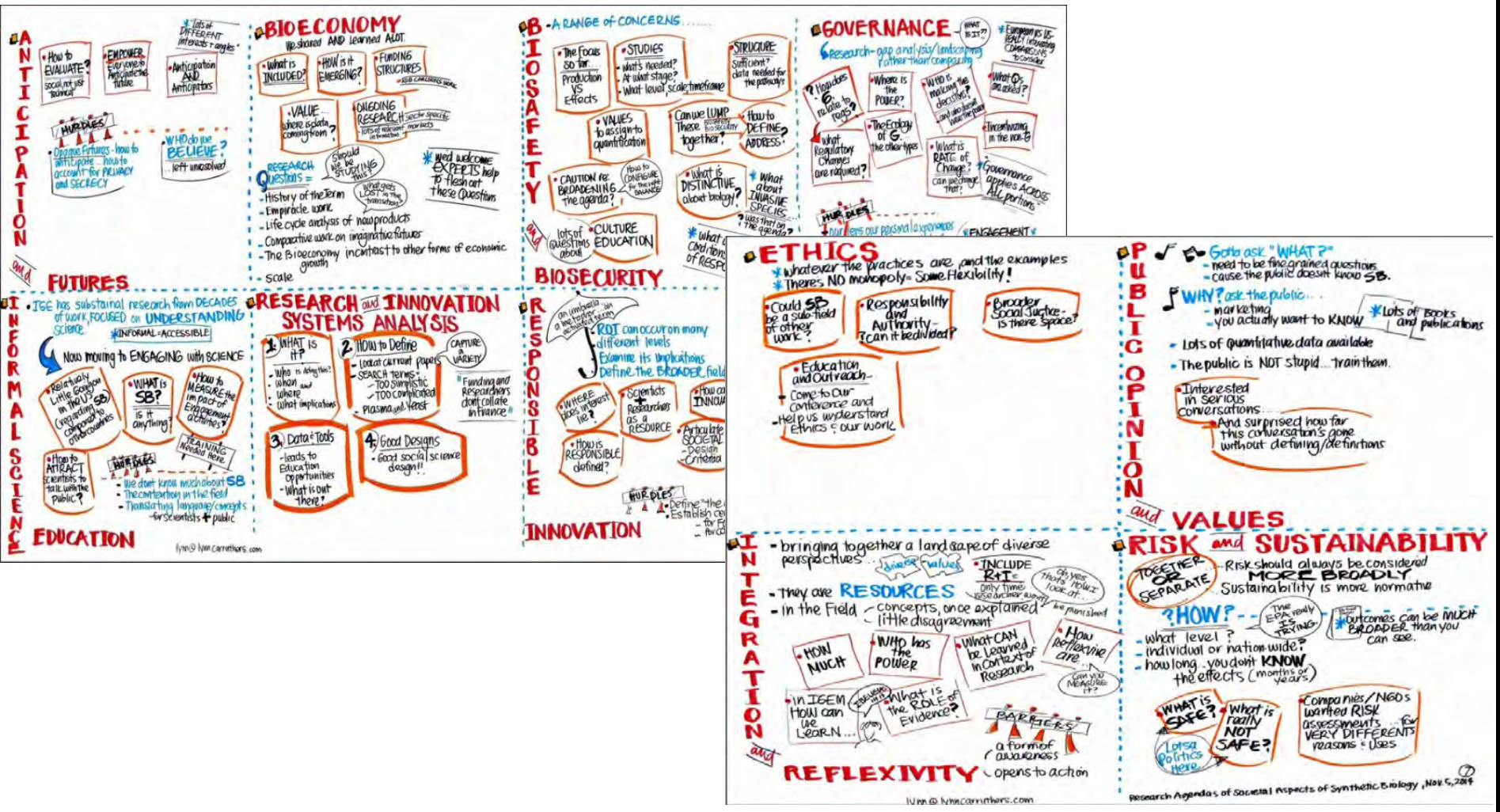


AN HOUR WITH ASU PRESIDENT CROW

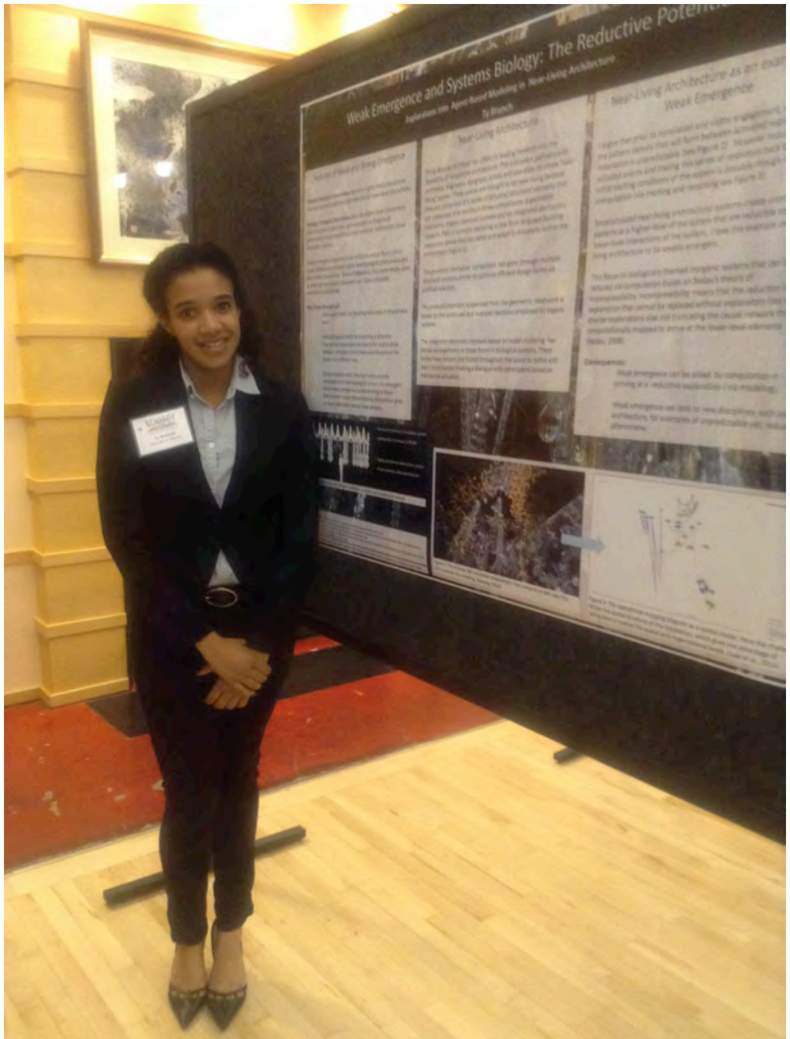
SESSIONS

- Anticipation & Futures
- Bioeconomy
- Biosafety & Biosecurity
- Governance
- Informal Science
- Education
- Research & Innovation Systems Analysis
- Responsible Innovation
- DIY/Makers
- Ethics
- Integration & Reflexivity
- Public Opinion & Values
- Risk & Sustainability

REPORT BACK FROM BREAK-OUT GROUPS: WHAT KIND OF WORK DO WE WANT TO DO?



POSTER SESSION



Multi-site public engagement with science - SynBio

Larry Bell & David Sittenfeld

Museum of Science, Boston

Abstract

The aim of this project is to foster activities in science museums through which public audiences can engage with scientists and engineers in conversations about synthetic biology. Conversations between researchers and public audiences will focus not only on what synthetic biology is and how research in the field is carried out, but also on the potential products, outcomes, and implications for society of this work. Researchers and publics will explore personal and societal values and priorities as well as research outcomes so that both groups can learn from each other. In the first year of the project, engagement activities will be tested at eight pilot sites across the U.S. and in the second year the project team will develop a kit of materials that will be distributed to 200 sites to support widespread public engagement with synthetic biology across the U.S.

While it involves public engagement, the project is really aimed at raising the capacity of science museums and scientists to engage the public in multi-directional conversations about the societal implications of a developing technology with potentially profound implications.

This project is funded by the Advancing Informal STEM Learning (AISL) program in the Division of Research on Learning in Formal and Informal Settings (DRL) with support from Systems and Synthetic Biology, BIOTECH, BIOCHEM & BIOMASS ENG.

Building a community of practice for PES

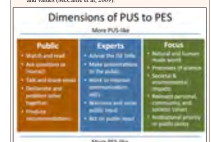
The MSPES-SynBio project brings together several large networks of researchers and informal educators to build a community of practice around public engagement with science.

- Sciencenter, Ithaca
- NY Hall of Science
- Mus of Life & Science
- Science Museum of Minn
- Pacific Science Center
- Chabot Space & Sci Cntr
- Arizona Science Center
- Museum of Science
- The Franklin Institute
- Oregon Mus of Sci & Ind
- Arizona Science Center
- Children's Mus of Houston

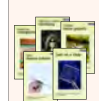
- Arizona State University
- Cornell University
- Genspace
- Massachusetts Inst of Technology
- North Carolina State University
- Rice University
- University of California-Berkeley
- University of Minnesota
- University of Washington

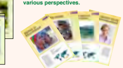
MSPES is aimed at moving from public understanding of science in informal education to public engagement with science

PES in terms of informal science education refers to activities, events, or interactions characterized by mutual learning—not one-way transmission from experts to publics—among people of varied backgrounds, scientific expertise, and life experiences who articulate and discuss their perspectives, ideas, knowledge, and values (McCallie et al, 2009).



Two examples drawn from nanoscale informal science education:

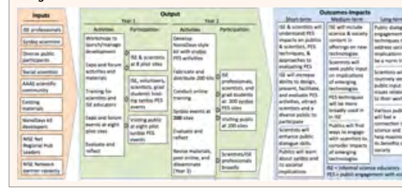




Example 1: Tabletop activities that engage exhibit hall visitors in consideration of priorities for technological development from various perspectives.

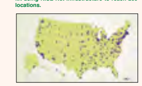
Example 2: Forums – dialogue programs – that engage experts and publics in multi-directional learning in dialogue about socio-scientific questions that cannot be answered by science alone.

Logic Model



Engagement events at pilot sites in 2015 and 200 sites in 2016

Museums matched with scientists for 2015 pilot activities followed by the distribution of a kit using NISE Net infrastructure to reach 200 locations.



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Societal aspects of synthetic biology: Organisms and contexts matter

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Oak Ridge National Laboratory, Oak Ridge, TN

Abstract

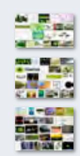
This poster focuses on a single proposition:

Research on societal aspects of synthetic biology should be specific about the organisms and contexts to which they apply.[1]

[1] Building upon Shumpert, BL, AK Wolfe, DJ Bjornstad, S Wang, MF Campa, 2014, Specificity and engagement: Increasing ELSI's relevance to nano-scientists. *Nanoethics* 8:193–200, DOI 10.1007/s11569-014-0194-x.

"Synthetic biology" entails tremendous diversity

- Definitions
- Technical approaches to modification
- Goals of modification
- Types of organisms modified
- Potential uses of modified organisms, their products, and byproducts
- Contexts of commercialization, production, dissemination, use, and disposal
  - Parties involved at different stages
  - Parties affected at different stages
  - Impacts at different stages
    - Extent, magnitude, duration, distribution…
    - Social, human health, environmental…
- Applicable regulations
- Etc.



Screen shots from Google "synthetic biology images" search

Specificity about "synthetic biology" matters…

Example: ***Governance***

Multiple sets of rules apply…here, from a formalized, federal perspective

Organism type	TSCA	FIFRA	CWA	NEPA	FDCA	APHIS (PPA)	ESA	NIH
Microbes	x						x	x
Plants		x		x	x	x	x	
Algae	x		x	x	x		x	x
General/not specified				x	x		x	x

Illustrative, not intended to be comprehensive.
References 1-13

Examples: ***Potential risks***

Potential risks vary by organism…whether considered from standpoints of human health or environmental risks or from an application perspective

Application

Organism type	Renewable energy	Medical	Agriculture, food, and environmental	Bioterrorism
Microbes		Unintended immune response caused by new cell therapies (4)	New or sturdier pests that are hard to control (4); Increased pesticide resistance (4); Growth of invasive species (4)	Creation of pathogenic viruses and bacteria (17)
Plants	Added pressure on land affecting food production, communities, and current ecosystems (4)		New or sturdier pests that are hard to control (4); Increased pesticide resistance (4)	
Algae	Competition with native algal species (4); Depletion of vital nutrients (4); Further spread to other ecosystems (4)			
General/not specified	Evolution of novel, potentially harmful characteristics (14); Uncontrolled proliferation (4); Contamination of surrounding environments (4); Undesired cross-breeding (4)	Evolution of novel, potentially harmful characteristics (14); Uncontrolled proliferation (4); Contamination of surrounding environments	Evolution of novel, potentially harmful characteristics (14); Uncontrolled proliferation (4); Contamination of surrounding environments	Threat to biosecurity (4); Do-it-yourself biologists lack necessary education and/or resources to conduct safe research with minimal risk (15)

Human Health

Organism type	Pathogenicity	Allergies	Toxicity
Microbes	Spread of infectious disease by needle sticks, or airborne transmission (4); Unintended infection from new cell therapies (4); Inadvertent increase in pathogenicity (8)	Unintended immune response caused by new cell therapies (4)	
Plants	Antibiotic resistance genes could be transferred to other organisms, eventually reaching humans and making pathogens less controllable (21)	Crops grown for pharmaceutical or industrial reasons could co-mingle with food crops (18); Food allergies from varieties equipped with new expression genes (20)	Transgenic organisms intended to be toxic to pests or pathogens could harm non-target species (18); Crops for pharmaceutical or industrial reasons could co-mingle with food crops (18); Increased risk of tumor growth from genetically modified food products (20)
Algae		Airborne algae can induce allergies (19	
General/not specified	Evolution of novel and potentially harmful characteristics (14)	Evolution of novel and potentially harmful characteristics (14)	Evolution of novel and potentially harmful characteristics (14)

Environmental

Organism type	Biodiversity	Land	Gene dispersal
Microbes	Competition with native populations (17, 22); Difficulty of eradication (17)		Horizontal gene transfer (17, 18, 22)
Plants	Competition with native populations (17); Difficulty of eradication (17)	Added pressure on land affecting food production, communities, and current ecosystems (4); Increase in weediness or invasiveness (18)	Horizontal gene transfer (18); Spread of transgenes by dispersal of whole organisms (18)
Algae	Competition with native algal species (4); Competition with native phytoplankton, ultimately resulting in alteration of food web dynamics and geochemical cycling (16); Depletion of vital nutrients (4)		Horizontal gene transfer (16, 18); Spread of transgenes by dispersal of whole organisms (18)
General/not specified	Further spread to other ecosystems (4)		Ability to mutate and evolve (17)

Illustrative, and based on our review of the literature
Numbers in parentheses refer to references in the box to the right

Specific synthetic biology attributes have substantive, potentially significant, implications for social science research

Incorporating such specificity can:

- Enhance research on societal aspects of synthetic biology
  - Upstream or public engagement, responsible innovation, public attitudes and opinions, communications, bioethics, governance, costs vs. benefits, risk, etc.
- Improve our collective ability to achieve multiple research goals
- Increase the "usability" of our research results among multiple target "user" populations

References (for tables)

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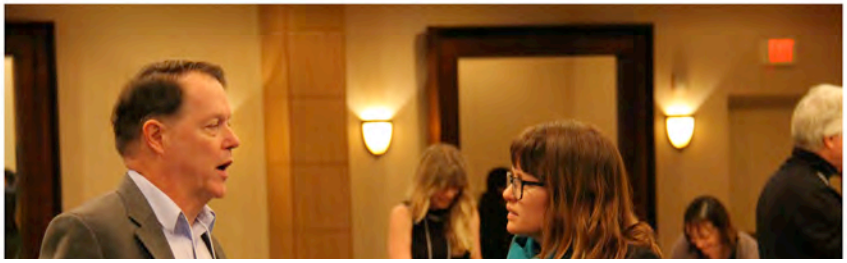
II


Economy - how to do
that, who should be
involved in what ways?
Role of Cyt-Bio?

THURSDAY PLENA



BIOECONOMY

Comparative and international research will be critical for making US policy in an era of the globalization of bioeconomies and of global biological systems. Participants grappled with what gets included and what gets ignored, the mechanisms by which a bioeconomy emerges and flourishes, and what gets lost/distribution of outcomes in that transition.

- **Significant lack of information and very few sources of data**
- **Research interests: history of the term, life cycle analyses of new products, comparative work on imaginative futures, and the bioeconomy in contrast to other forms of economic growth**

RESPONSIBLE INNOVATION

Effort to try to establish more clearly articulated societal design criteria, expand the solution space, and make choices more explicit and transparent

- How can innovation systems internalize RI processes as distinct from regulatory oversight?
- What are the conditions that would make responsible development in syn bio possible? What processes and institutions do we need?
- Systematic consideration of alternative pathways for achieving stated goals of synthetic biology research. For a given “promise”, what are other social/technical means of delivering on it?

GOVERNANCE

Governance is not just about regulations, but the interactions among different sources of power in society. Therefore, there is a need for creativity, flexibility and new analytic and policy frameworks.

- Can governance issues be generalized across emerging technologies?
- Participants requested assistance from federal agencies for creating formal pathways for research to reach policymaking bodies. Strengthening (or creating, in some cases) a more efficient feedback loop between social scientists, policymakers and scientists is a critical need.
- Coordinated and systematic mappings of international/ transnational policies and governance structures as they emerge to produce comparative analyses of policies.

STYLE

The most important concern was finding the right balance of integrative and independent social science research.

- **Embeddedness model keeps social science grounded and real**
- **The technical and social sides do not dictate what the other does; differences are complementary and open up research possibilities through awareness and humility**
  - Specific mechanisms, such as mechanism in review process to decline funding for a poorly integrated and embedded project, may help promote appropriate degree of independence

SCALE

Absent a large national synthetic biology program, do we need or want a large 'societal aspects of synthetic biology program?

- **Important opportunity to step away from the "ethical, legal and social implications" (ELSI) model in which the social side is funded only through the technical side.**
  - ELSI model minimizes scope and credibility of social science and humanities work by making it contingent on scientific funding
- **Large scale and independent funding critical for success of cooperative and collaborative research agendas**

RECOMMENDATION 1

Federal agencies sponsoring synthetic biology should pay special attention to societal research on synthetic biology, even in the absence of a national initiative.

RECOMMENDATION 2

Federal support for synthetic biology should ideally pursue a co-constructed synthetic biology that would develop a truly integrated research program and be a model of responsible innovation.

RECOMMENDATION 3

Federal support for societal research on synthetic biology should include large-, medium-, and small-scale activities in order to achieve appropriate combinations of independence and interdisciplinary coordination.

RECOMMENDATION 4

A funding model that relies solely on co-funding societal research with science and engineering research should not be pursued; nevertheless, co-funding should still be an important instrument and proposals from both societal and S&E investigators should be evaluated in part by how well they integrate knowledge across disciplines.

RECOMMENDATION 5

Federal support for synthetic biology should be sensitive to the power differentials between S&E researchers and societal researchers in designing funding models and articulating expectations.

RECOMMENDATION 6

Federal support for synthetic biology should be prepared to fund societal research in a number of fields and design programs to take advantage of potential synergies across them.

RECOMMENDATION 7

Federal support for synthetic biology should consider and develop ways of connecting societal research with informal science education about synthetic biology, among other areas.

RESOURCES:
CNS.ASU.EDU/SYNBIO

Workshop agenda
Workshop posters
Workshop reflections
Workshop reports (workshop/eval)
Interviews (coming soon)
Background papers
Bibliography
Glossary

RESEARCH AGENDAS of the SOCIETAL ASPECTS of SYNTHETIC BIOLOGY
Nov. 4-6, 2014
Tempe AZ

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