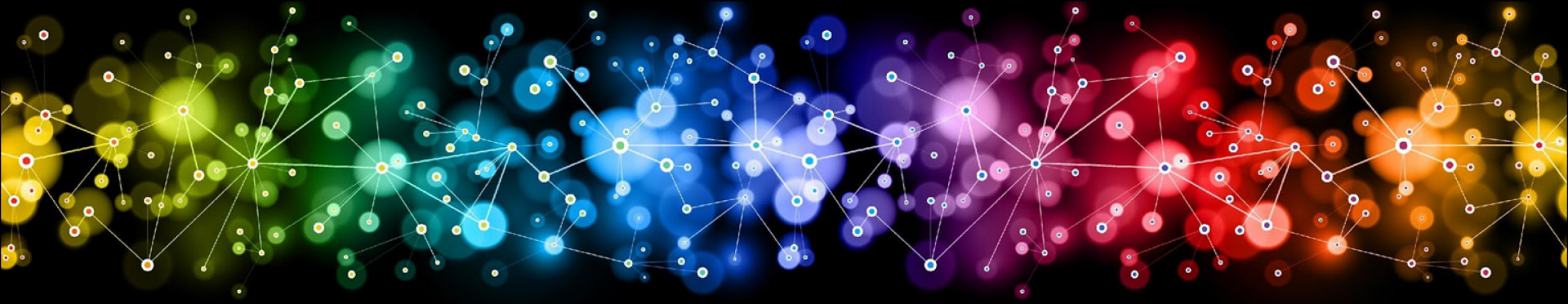


# GROWING CONVERGENCE RESEARCH OUTREACH SERIES

An Introduction to the Growing Convergence Research Program

Presented by:

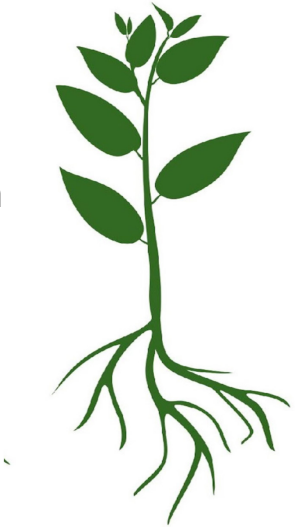
The National Science Foundation & The Toolbox Dialogue Initiative Center

March 14, 2024

Organized By: TOOLBOX DIALOGUE INITIATIVE™

# AGENDA

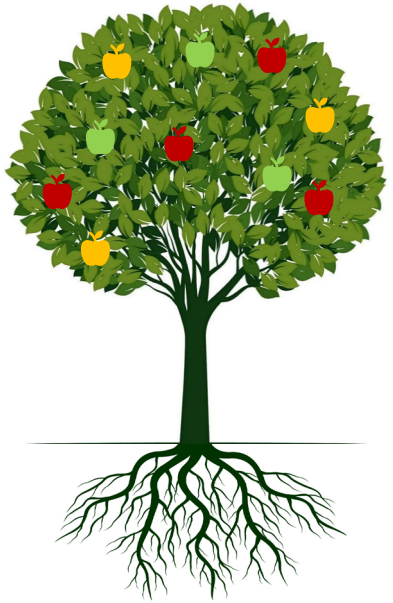
- **Part I: GROWING CONVERGENCE RESEARCH program**, NSF presenters
  - Dragana Brzakovic, dbrzakov@nsf.gov
  - Steven Breckler, sbreckle@nsf.gov
  - Rebecca Morss, reellis@nsf.gov
- **Part II: CONCEPTUALIZING & OPERATIONALIZING CONVERGENCE,** TDI team
  - Chet McLeskey, chetmcleskey@toolboxdialogue.com
- **Part III: PANEL: OPERATIONALIZING CONVERGENCE**, GCR awardees
  - Kimberly Gokoffski, Kimberly.gokoffski@med.usc.edu
  - Delphis Levia, dlevia@udel.edu
  - Charles Schweik, cschweik@umass.edu
- **Part IV: Q&A**



# Cultivation of Convergence Research at NSF

**GROWING CONVERGENCE RESEARCH PROGRAM**

**OTHER NSF PROGRAMS AND INITIATIVES**



**CONVERGENCE ACCELERATORS**

# Characteristics of Convergence Research Supported by GCR

- *Research driven by a specific and compelling problem.* Convergence Research is generally inspired by the need to address a specific challenge or opportunity, whether it arises from deep scientific questions or pressing societal needs.
- *Deep integration across disciplines.* As experts from different disciplines pursue common research challenges, their knowledge, theories, methods, data, research communities and languages become increasingly intermingled or integrated. New frameworks, paradigms or even disciplines can form sustained interactions across multiple communities.

# Growing Convergence Research Program Goals

The NSF GCR program aspires to build new research capacity **by growing the earliest foundations of convergent approaches** for addressing a specific and compelling problem resulting in **paradigm shifting approaches** within disciplines, establishment of **new disciplines** and scientific communities, or development of **transformative technologies** that have the potential for broad scientific or societal impact.

# Growing Convergence Research
# Points of Emphasis

- Cultivating and growing the *earliest foundations* of convergent approaches.
- Exploring *novel avenues* not previously investigated.
- Developing *highly innovative solutions* to complex research problems.

# Growing Convergence Research
# Unique Program Features

- Five-year research plan, organized as two phases (2 + 3 years)
- Initial funding for first two years, up to $1.2 million
- Mandatory workshop at start of award
- Reverse site visit near the end of Year 2
- Phase II funding requires exceptional progress in Phase I

# Growing Convergence Research Special Review Criteria

- Compelling and ambitious motivating vision
- Deep and unique integration
- Clearly organized goals for two phases
- Innovative research activities well-suited to building convergence
- Appropriate convergence management plan
- Appropriate and essential team; integrated partners

# Understanding Growing Convergence Research

- *Research*
  - explore novel avenues not previously investigated that are at the forefront of advancing science
  - catalyze scientific discovery and innovation at the nexus of disciplines
- *Convergence*
  - research driven by a specific and compelling problem + deep integration
  - identify which elements of different disciplines will be contributing to the convergence project and how the team plans to deeply integrate those elements
- *Growing*
  - grow new scientific areas / new forms of deep integration across disciplines
  - not only create solutions to the specific problem studied, but also develop novel ways of investigating related research questions and open new research vistas

# *Conceptualizing Convergence*

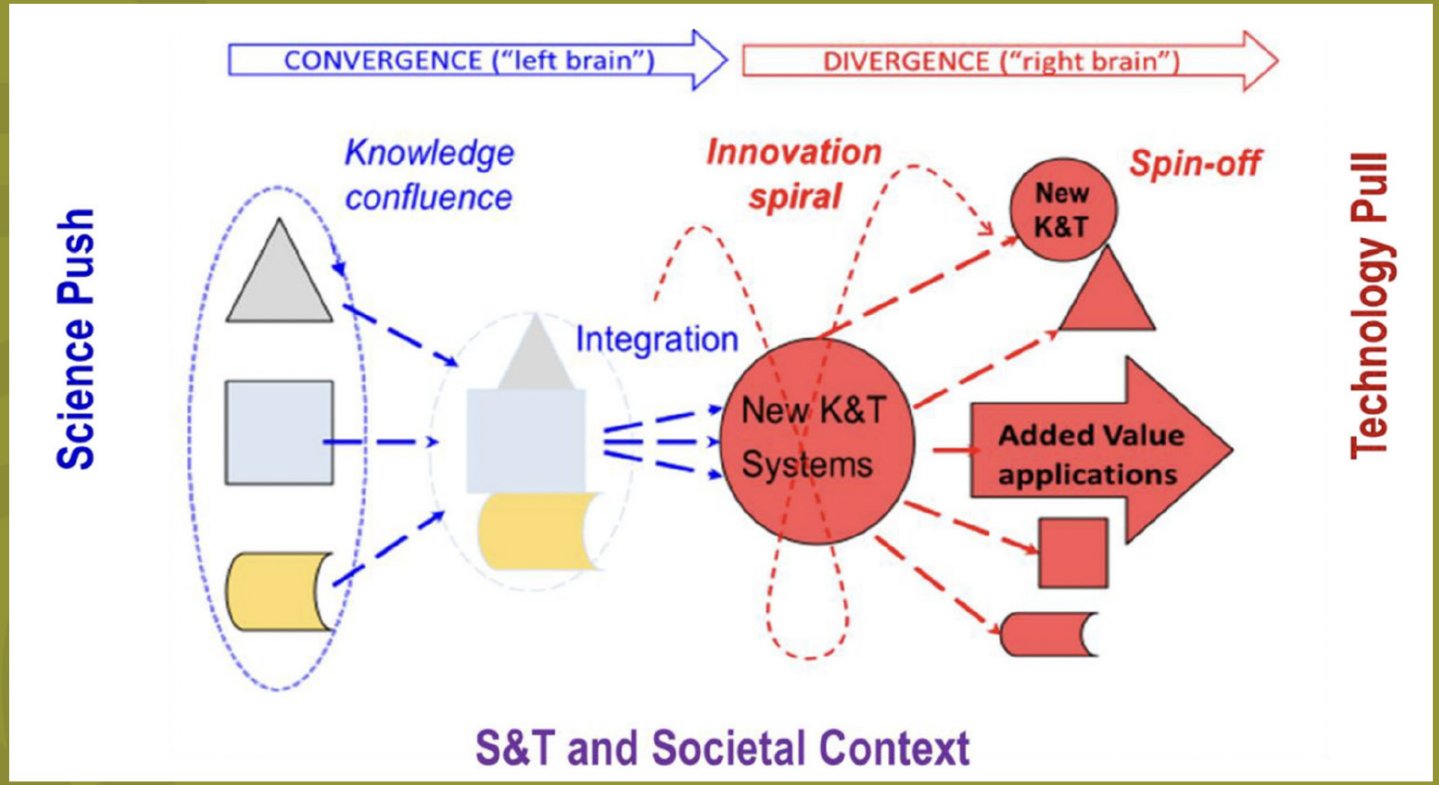
**Toolbox Dialogue Initiative**
**http://tdi.msu.edu/**

# Chet McLeskey

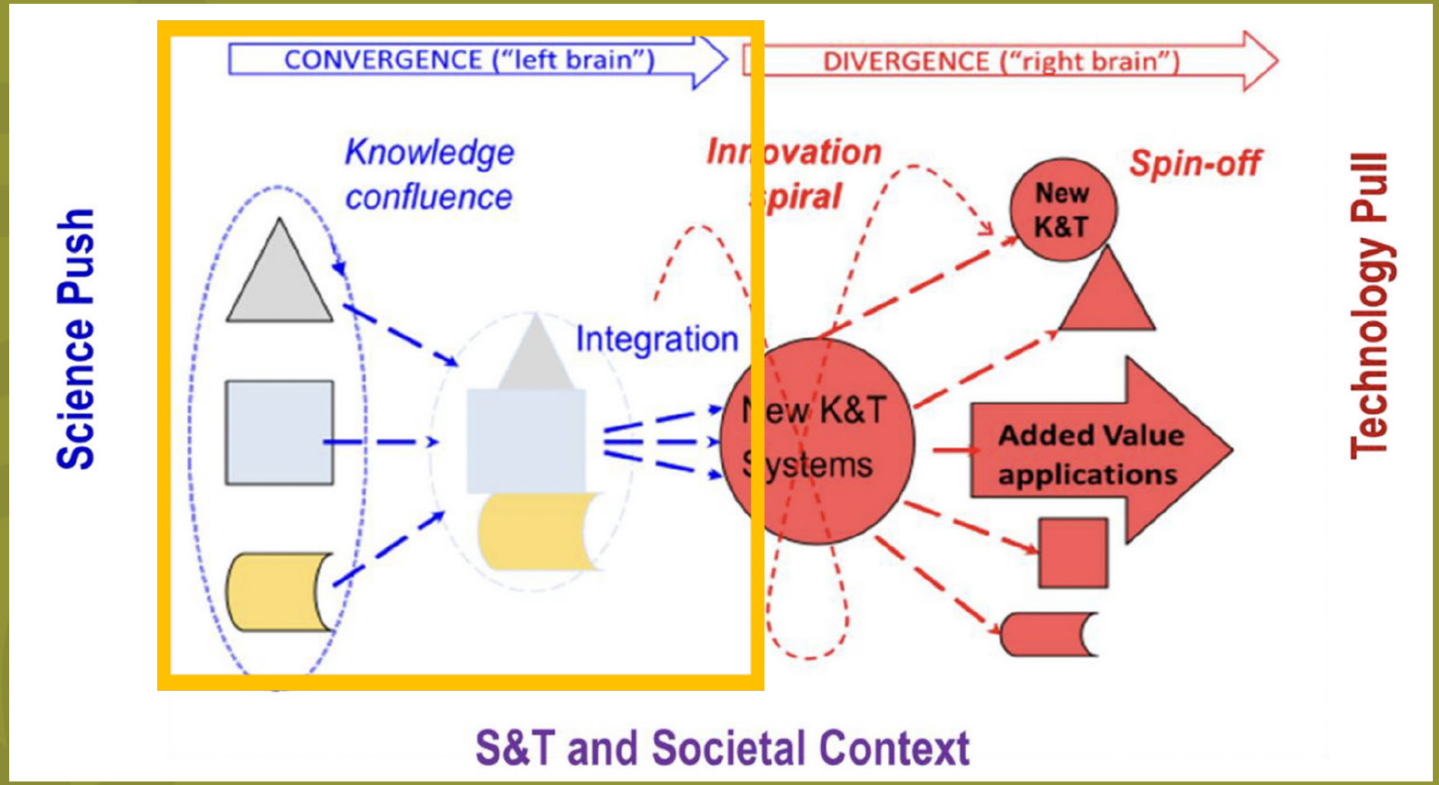
- Associate Director, Toolbox Dialogue Initiative Center, Michigan State University
- PhD in Philosophy
- Epistemology of expertise, team science, and communication; research ethics

*Convergence is "the escalating and transformative interaction among seemingly distinct scientific disciplines, technologies, communities, and domains of human activity to achieve mutual compatibility, synergism, and integration, and through this process to create added value and branch out into emerging areas to meet shared goals."*

*Roco et. al. 2014 [p.xiii]*




Roco, M. C. (2020). Principles of convergence in nature and society and their application: from nanoscale, digits, and logic steps to global progress. *Journal of Nanoparticle Research,* 22; 321.




Roco, M. C. (2020). Principles of convergence in nature and society and their application: from nanoscale, digits, and logic steps to global progress. *Journal of Nanoparticle Research,* 22; 321.

# GCR Definition of Convergence Research

I. ”Research driven by a specific and compelling problem” that addresses specific challenges or opportunities that come from “deep scientific questions or pressing societal needs” *

II. Deep integration of different perspectives from inside and outside the academy that can lead to “new frameworks, paradigms, or even disciplines” *

* National Science Foundation. (2019). Convergence research at NSF. Online at https://www.nsf.gov/od/oia/convergence/index.jsp

# A Convergence Challenge

I. The goal of convergence is to meet complex problems with complex responses

II. Diversity of expertise is key, but integrating it without washing out differences is a challenge

# An Accelerated Challenge

This challenge is intensified by the need to act fast:

- There is little time to let things happen organically–attention to process is critical
- You must build mutual understanding that supports meaningful convergence during Phase I*

* NSF. (2019. Growing Convergence Research (GCR). Online at https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505637.

# Two Aspects of Convergence Research

TOOLBOX DIALOGUE INITIATIVE ™

I. *Deep* Integration – about *perspectives*

II. Convergence Culture – about *people*

*"...we've got some concepts coming in from biology. And now, oh, wow! We need to actually rethink the way that that's going to be done. So I'd argue, [convergence research is] a lot more open-ended in that sense as compared to typical sort of engineering or science based proposals where you sort of have these hypotheses, and you're going to test them. And then you're moving along in a well defined trajectory with regards to this, to that."*

# Integration in the GCR Solicitation

TOOLBOX DIALOGUE INITIATIVE ™

I. Proposals submitted to this solicitation are expected to:
   - Explore novel avenues to advance science through deep integration
   - Identify disciplinary elements to be deeply integrated
   - Describe how conceptual models, tools, methodologies from multiple disciplines will be deeply integrated in new ways
   - Articulate how tasks and forms of expertise will be deeply integrated over the course of the project

# Step 1: Knowledge Confluence

I. Perspectives, knowledge, methods, and values from disparate sources are brought together to address a specific problem
   - Disciplines that rarely work together
   - Sources from outside the academy

II. This combination can yield new insights *if integrated*
   - Integration can motivate unprecedented changes in conception, methodology, and understanding

# Step 2: Deep Integration

I. Inputs come together in synergistic and mutually dependent ways
   - Combinations of inputs lead to outputs that cannot simply be reduced to the sum of those inputs

II. Leads to novel ways of conceiving a problem and what paths may be open to solve it
   - Gaps in understanding are filled and new gaps discovered
   - New methods of knowledge attainment result from a more comprehensive understanding of the issue

# Charting a path to convergence

TOOLBOX DIALOGUE INITIATIVE ™

I. Attention to the *process* of convergence is critical

II. GCR wants an account of past, present, and future convergence—**need to tell that story**

# Integrative Pathways & Mechanisms

I. Integrative pathway:

- A series of changes to inputs that results in the production of an integrated output

II. Integrative mechanism:

- A device, system, tool, or approach that facilitates the combination of inputs into an integrated output

# Examples of Integrative Mechanisms

I. Create a ***common goal*** to which collaborators can contribute, perhaps in sequence – e.g., conduct interviews to determine the environmental variables to foreground

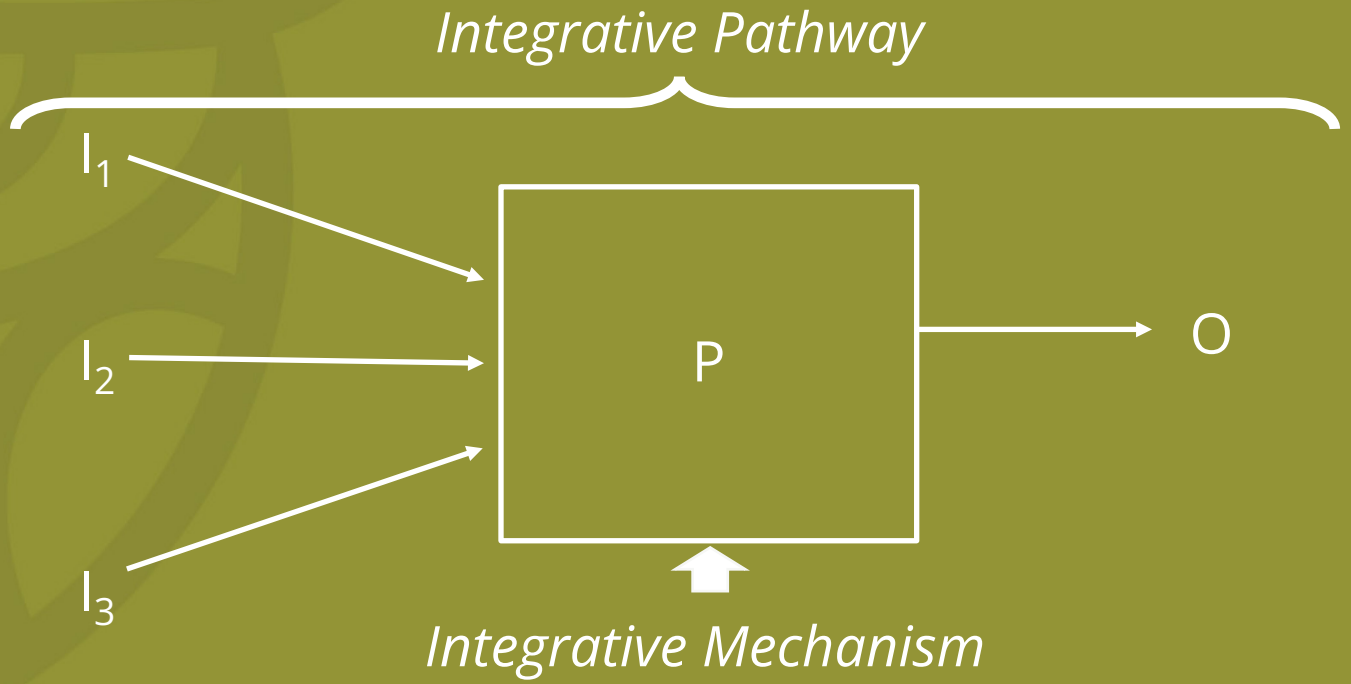
II. Use a ***boundary object*** (e.g., an urban area, a watershed) to reveal relationships among different perspectives

# Examples of Integrative Mechanisms

III. Use ***GIS*** to related different types of information (e.g., social, economic, physical) about a location

IV. Create a ***model (e.g., a concept map)*** of the system that elucidates causal relationships among different parts

# Integrative Pathways & Mechanisms



*"...[what] was really important for convergence for us, [was] going through that process in such an intense and consistent way really opened up a layer, and a platform for trust, and being able to bring your own vulnerabilities within your discipline–things you don't know, things you're curious about–things that often scientists kind of filter. And so that's when I think we knew that we had really converged–when we were sharing everything, in the open, and that was really key because then that allows you to be even more creative."*

# Culture in the GCR Solicitation

TOOLBOX DIALOGUE INITIATIVE ™

I. Proposals submitted to this solicitation are expected to:
   - “Articulate how they will intentionally bring together their research team and develop a convergent culture of discovery and communication”
   - Describe “new training and learning experiences for participants at all levels, most importantly for post-docs and graduate students” which is essential to “a convergent culture”

# Convergence Culture

I. Communication dynamic that supports relationship building and information transfer within teams

II. Common ground that supports integration

III. Common technical language

IV. Development of a culture that extends beyond individual teams and into the greater research community

# Key Components of  Culture

I. Psychological Safety

II. Mutual Respect

III. Trust

IV. Commitment to process

# Communication as Central

I. Central to the project culture you develop will be *communication*, understood both relationally and informationally
   - Communication is the *sine qua non* of convergence research
   - Supports the key components
   - Encourages skills like reflexivity and perspective taking
   - Skills require practice*

* O'Rourke, M., Rinkus, M. A., Cardenas, E., McLeskey, C. (2023). Communication practice for team science. In Gosselin, D. C. (Ed.), *A practical guide for developing cross-disciplinary collaboration skills* (pp. 83-102). AESS Interdisciplinary Environmental Studies and Sciences Book Series. Cham: Springer.

# Some Suggestions

I. Attend to process

II. Be curious

III. Be present

IV. Don't forget the social side of teamwork

V. Remember to *practice* being a team!

# Convergence Panel

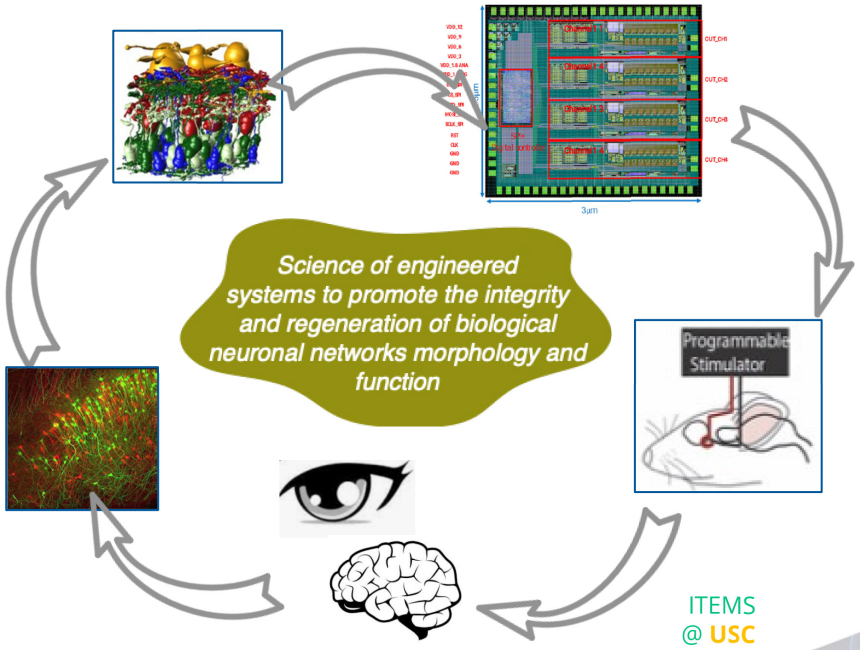
- 3 Panelists from different Phase II funded teams
- Answering questions that will be posted in the chat
- Here to share experiences and sage-like wisdom

# Kim Gokoffski MD PhD, Reprogramming Biological Neural Networks with Field-Based Engineered Systems, 2021

- Goal: Develop electrical stimulation systems to activate endogenous cellular pathways to repair damaged neural networks in **Glaucoma** and **Alzheimer's Disease**

- Early success: Ecosystem changes that allowed us to establish deeply interconnected in-common goals early-on.

- Transformative success: Formation of University-wide centers and symposia to generate "multi-lingual" students who are the next generation of scientists




ITEMS @ USC

Gianluca Lazzi, PhD, Kimberly Gokoffski MD PhD, Michael Bienkowski PhD, Constantine Sideris PhD, Mark Humayun MD PhD

# Delphis Levia, GCR: Life Cycle Management of Materials: Sustainable Biomass to Designer Polymer Systems, 2019

- This project tackles lignin valorization from “A to Z”
- Frequent meetings are critical at the start (proposal and project stages); mind mapping activity; development of a shared lexicon is key
- Successful convergence of ecohydrology, catalysis, polymer science, and ecotoxicology; also international convergence and deep integration with Forestry & Forest Products Research Institute (Japan)
- Investigating further funding opportunities to leverage even deeper convergence in the context of new research lines enabled by GCR funding to promote wiser resource use

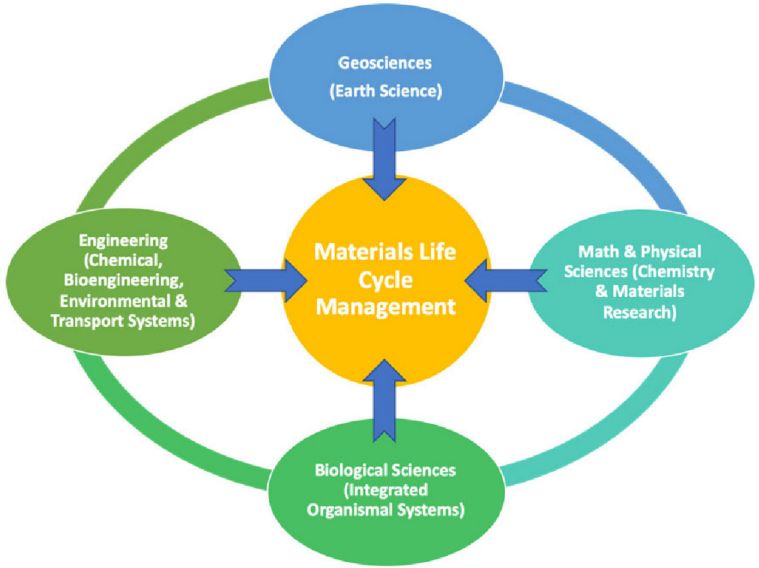



**Figure 1:** Overview of proposed convergent discipline of Materials Life Cycle Management

T. Keyes, III (PI), D. Levia, D. Vlachos, A. Kunjapur, C. Wu (Co-PIs), University of Delaware
Contact via email: dlevia@udel.edu

# Charlie Schweik, GCR: Jumpstarting Successful Open-Source Software Projects With Evidence-Based Rules and Structures, 2020

- **The Problem**: How to sustain Open-Source Software (OSS) that our world depends on.
- **Convergence**: Combining "Socio-Technical" (Software Engineering), Approaches to the study of digital Communications and "Institutional Analysis" (Governance)
- **Convergence successes**:
  - Longitudinal analysis of "digital traces" related to OSS Socio-Technical-Governance
  - Advancing toward "Computational Institutional Analysis" – a possible new field

Vladmir Filkov & Seth Frey -UC Davis, Brenda Bushouse-UMass Amherst (Co-PIs);
Curtis Atkisson, Postdoc. https://reposs-sustain.github.io/;
Contact via email: cschweik@umass.edu