28th Annual INCOSE international symposium

Washington, DC, USA
July 7 - 12, 2018

Session 7.5.3 – Presented by James Martin

Envisioning Systems Engineering as a Transdisciplinary Venture

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Purpose - Fellows Initiative

- *A Task Team of INCOSE Fellows to write a white paper that contains a definition of systems engineering that reflects the consensus for INCOSE Fellows.*
- *The purpose of this white paper is to distill the discussion of the definition of Systems Engineering so it is constructive and helpful to*
  - *Systems Engineering practitioners, and*
  - *those who need to know about the value of Systems Engineering.*

Fellows' Initiative - Task statement (May 2016)

Transformation of SE

Present paradigm	**Future** paradigm
robust, dependable, mainly-technological, **"deterministic systems"**	resilient, adaptive, **"evolutionary"** systems and systems-of-systems ➢ encompassing products, services, people and enterprises ➢ integrating technological, social and environmental elements
implicitly, a **command and control** view of how SE works`	explicitly, a **collaborative** way that SE better facilitates **engagement** with a variety of stakeholder groups

Proposed Definition *(changes highlighted)*

Systems Engineering is ~~an interdisciplinary~~ a **transdisciplinary** approach and means, based on systems principles and concepts, and applying scientific, technological and management methods, to enable ~~the realization of~~ successful realization, use and retirement of **engineered** **systems**.

Focus of this Paper

"Crossing boundaries is a defining characteristic of our age."

—Julie Klein, 1996

Transdisciplinarity is an elusive concept…

WHAT, WHY, WHO

The challenge of defining TransDisciplinarity (TD)

- Definitions vary among scholars
- Not yet defined in dictionaries
- The term is often (mis)used interchangeably with **inter**disciplinarity
- Sometimes defined metaphorically

WHAT, WHY, WHO

“Trans -”

(across, beyond, through, to the other side)

+

“discipline”

(1. an organized field of knowledge; 2. a set of rules)

WHAT, WHY, WHO

Key characteristics of the TD research model

- Problem-driven
- Action-oriented
- Highly collaborative
- Integrative
- Socially relevant

WHAT, **WHY**, WHO

The need for TD arises in response to four major concerns:

1. A growing concern about a host of urgent complex real world problems
2. The need to seek solutions to these problems
3. A realization that contemporary science can neither properly understand nor address these urgent problems
4. The need for a more democratic governance of knowledge production

TD can help us make sense of an increasingly complex, interconnected world…

Examples of complex urgent real world problems that TD aims to address:

- Environmental pollution
- Human rights violation
- Spread of antibiotic resistance
- Nuclear insecurity
- Unsustainable use of resources
- Health risks from new technologies

WHAT, WHY, **WHO**

Transdisciplinarity is a new way of conducting research, in which **multiple contributors and stakeholders**, both **from within and from outside academia**, are **working together** on identifying specific real-world problems and on finding solutions to these problems.

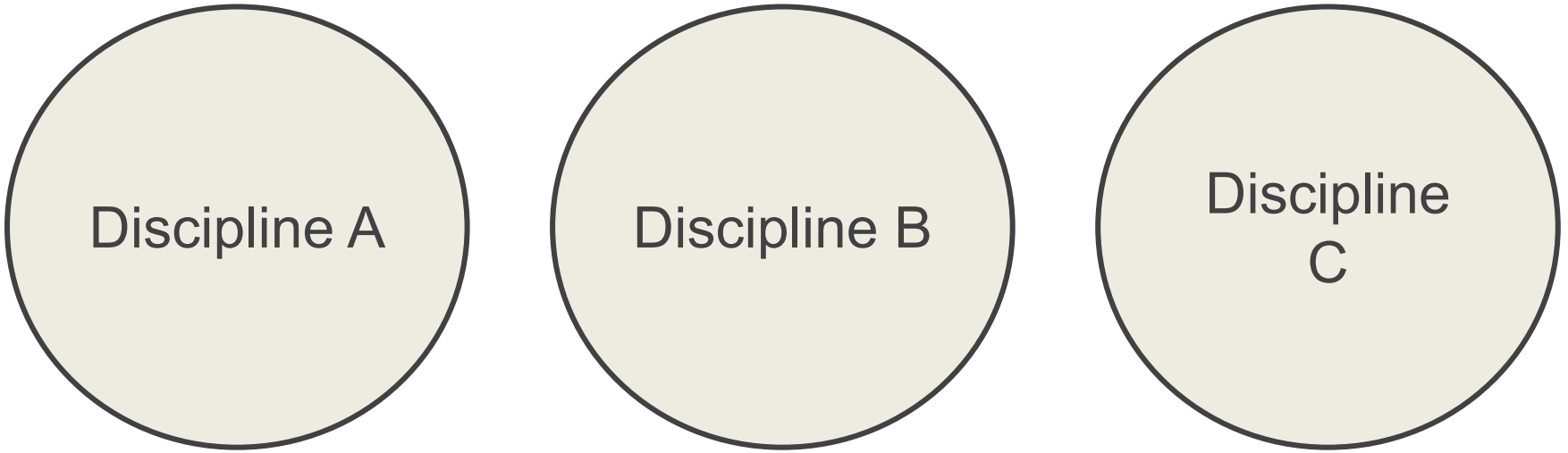
WHAT, WHY, **WHO**

"The man who wears the shoe knows best that it pinches and where it pinches, even if the expert shoemaker is the best judge of how the trouble is to be remedied."

— John Dewey, 1927

DISCIPLINARITY

MULTIDISCIPLINARITY INTERDISCIPLINARITY TRANSDISCIPLINARITY



DISCIPLINARITY

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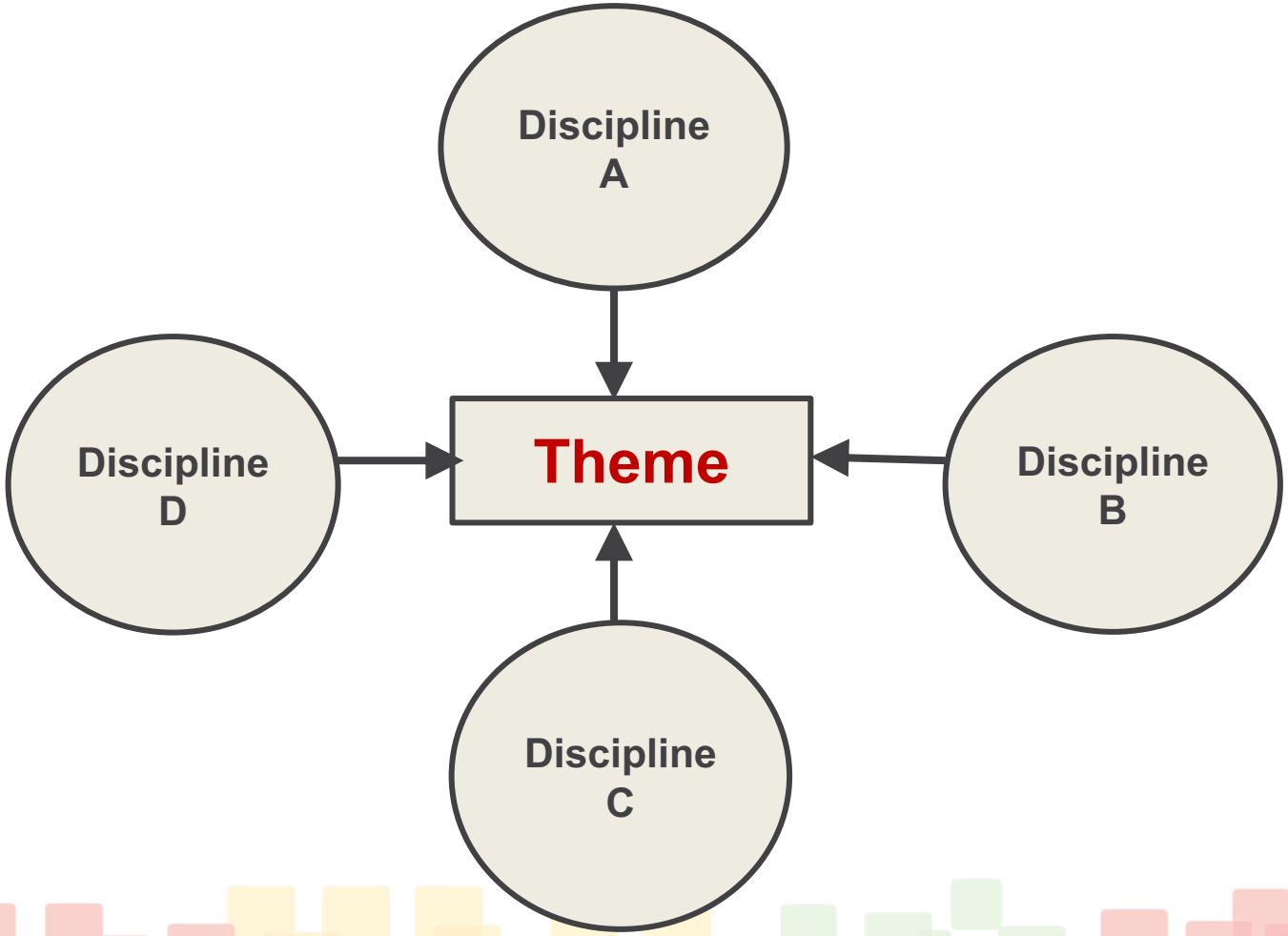
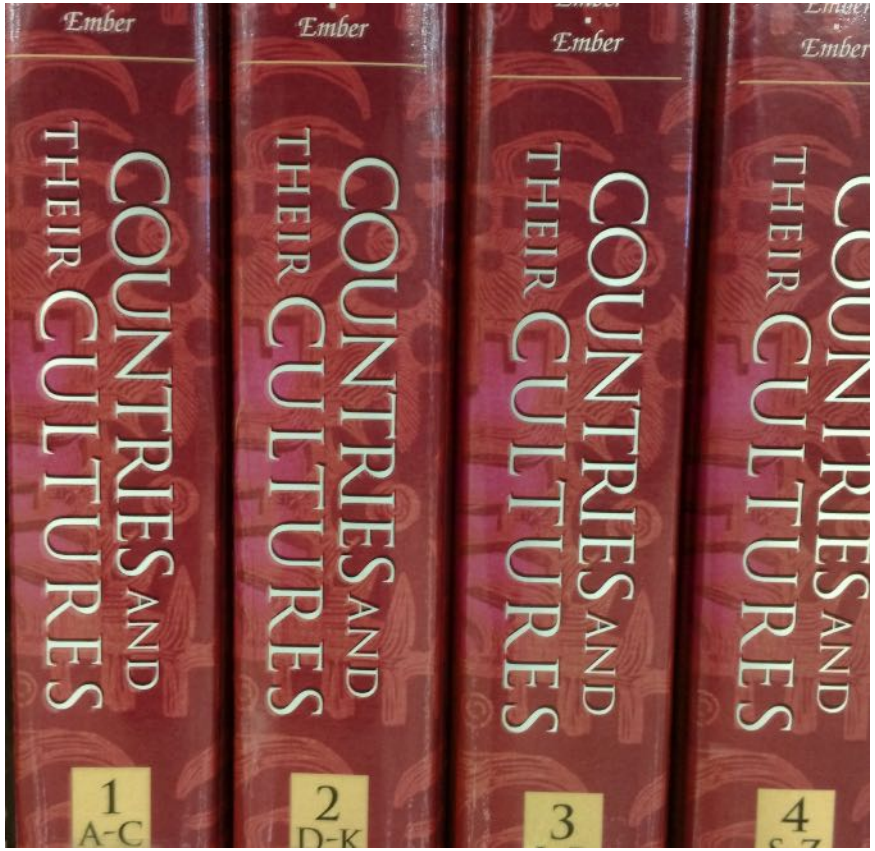


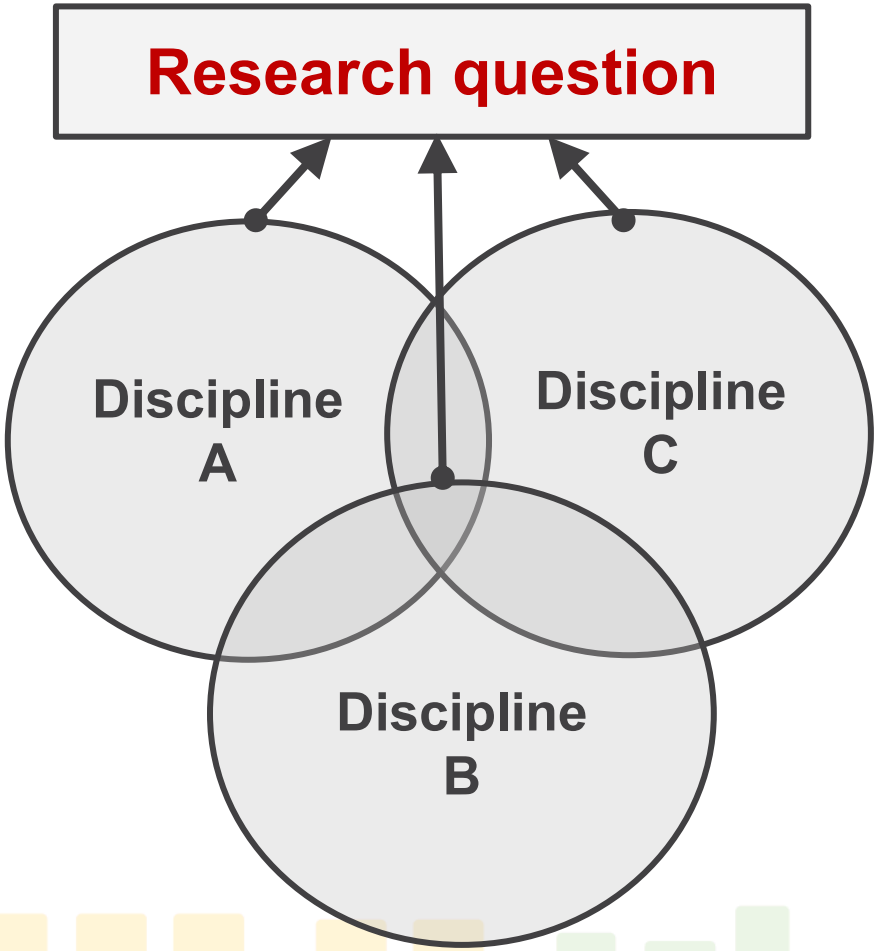
An example of a multidisciplinary project



A multi-volume encyclopedia "*Countries and their cultures*"

DISCIPLINARITY

MULTIDISCIPLINARITY **INTERDISCIPLINARITY** TRANSDISCIPLINARITY



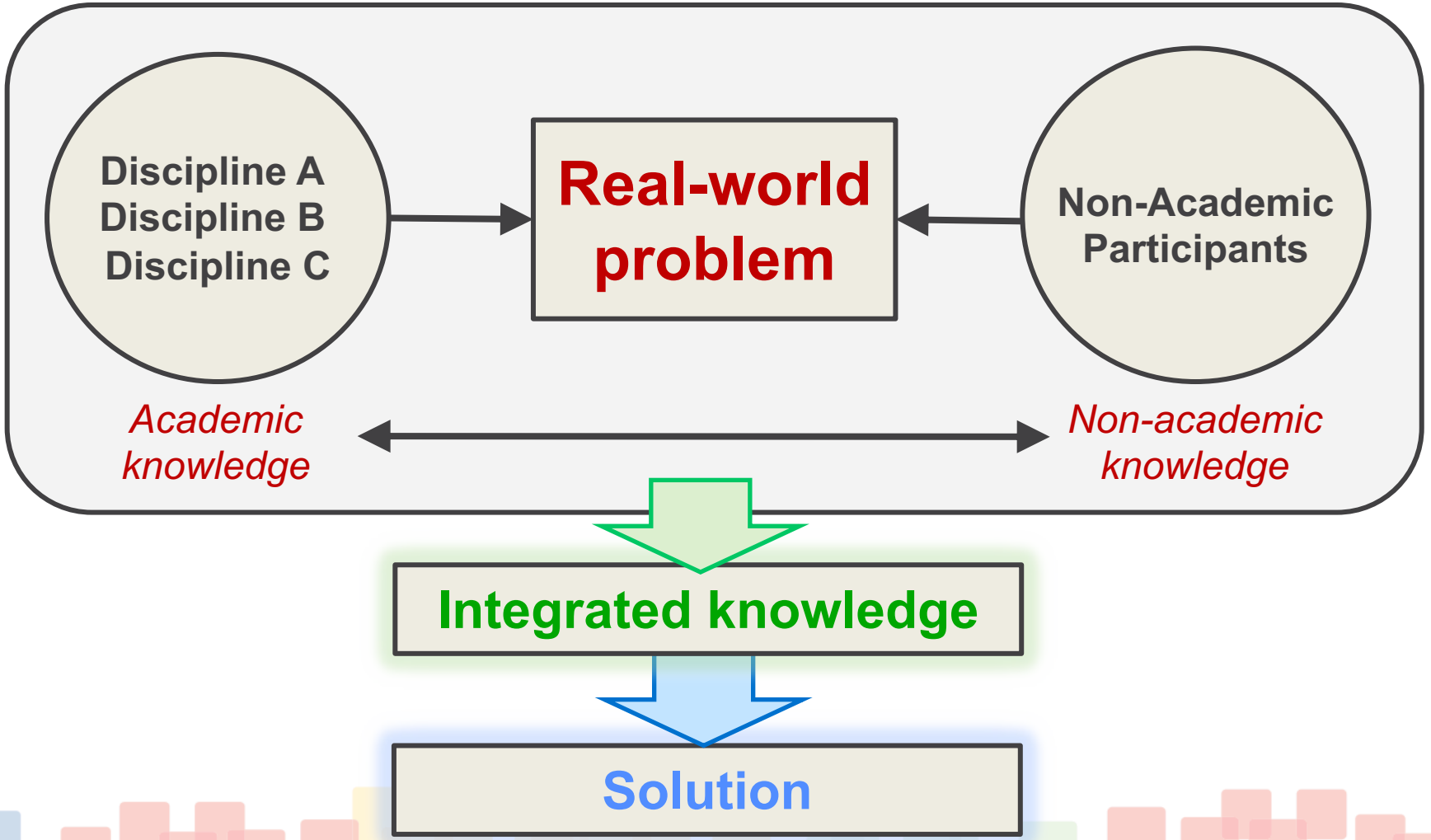
Examples of interdisciplinary fields

Paleontology

Biomimicry

DISCIPLINARITY

MULTIDISCIPLINARITY INTERDISCIPLINARITY **TRANSDISCIPLINARITY**



WHAT, WHY, WHO

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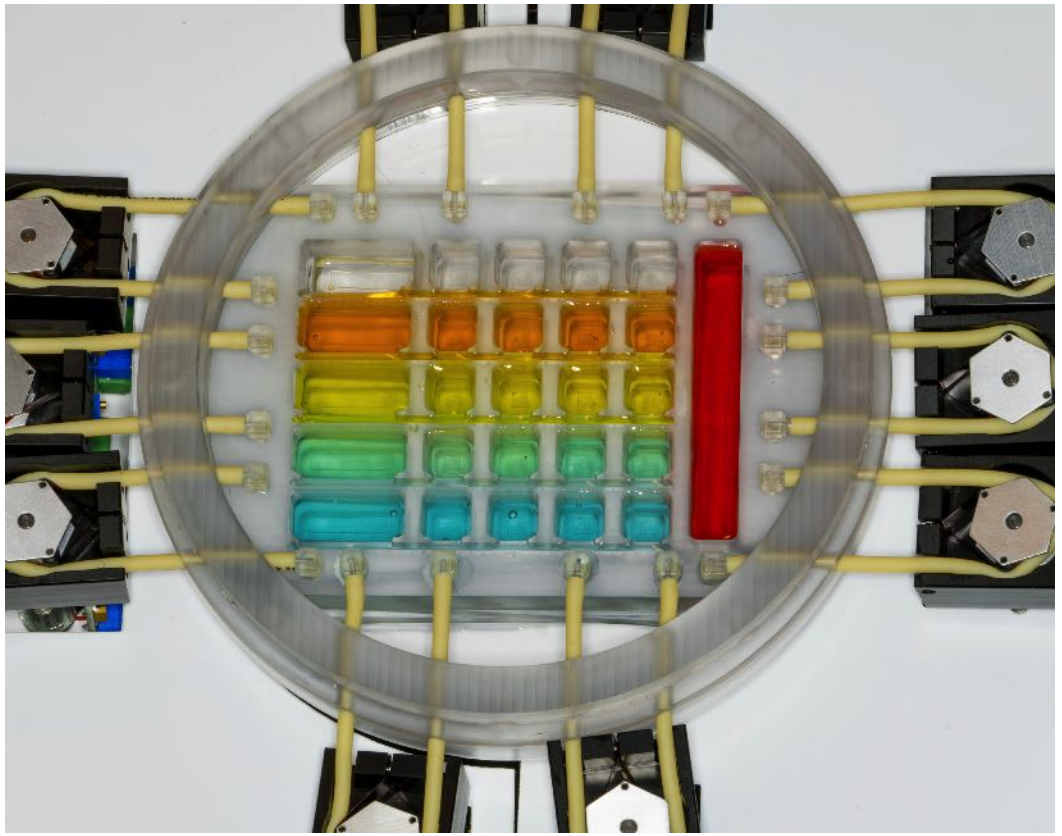
Example of a transdisciplinary project

- ✓ **Problem-driven**
  Addresses the problem of drug failure in clinical trials
- ✓ **Action-oriented**
  Develops 3-D human tissue chips to predict drug safety in humans
- ✓ **Highly collaborative**
  Collaboration between NIH, DARPA, and FDA
- ✓ **Integrative**
  - ❑ *Academic knowledge:* tissue engineering, chemistry, biology, physiology, microfluidics, regulatory science
  - ❑ *Nonacademic knowledge:* community organizations and patient groups
- ✓ **Socially relevant**
  Translates scientific discoveries into the real world



The Tissue Chip for Drug Screening project

Key Tenets of 21st Century SE

The Twelve Systems Engineering Tenets	
1	Understand what success means
2	Consider the whole problem, the whole solution and the full lifecycle
3	Understand and manage interdependencies
4	Adapt the parts to serve the purpose of the whole
5	Recognise that Systems Engineering occurs at multiple levels
6	Base decisions on evidence and reasoned judgement
7	Recognize uncertainty while managing change, risks, opportunities and expectations
8	Handle structure and behaviour as two complementary aspects of any system
9	Understand and use appropriate feedback
10	Understand and manage value
11	Be both systemic and systematic
12	Respect the people

Tenets Most Relevant for TD Approach

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Transdisciplinary “Attitude”

- Open-mindedness
- Intellectual flexibility
- Combinatorial creativity
- Capacity for dialog and collaboration
- Intellectual humility

Conclusion

“Transdisciplinarity is not a single form of knowledge but a dialogue of forms.”

– Kate Maguire, 2015

So, How do we proceed?

- **Transdisciplinary Approach**
  - Bring stakeholders *into* the process
  - *Continuous* engagement with non-technical groups and individuals
- **Servant Leadership**
  - SE doesn't have all the answers
  - We don't even have all the questions!

Questions and Discussion

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Thank You!