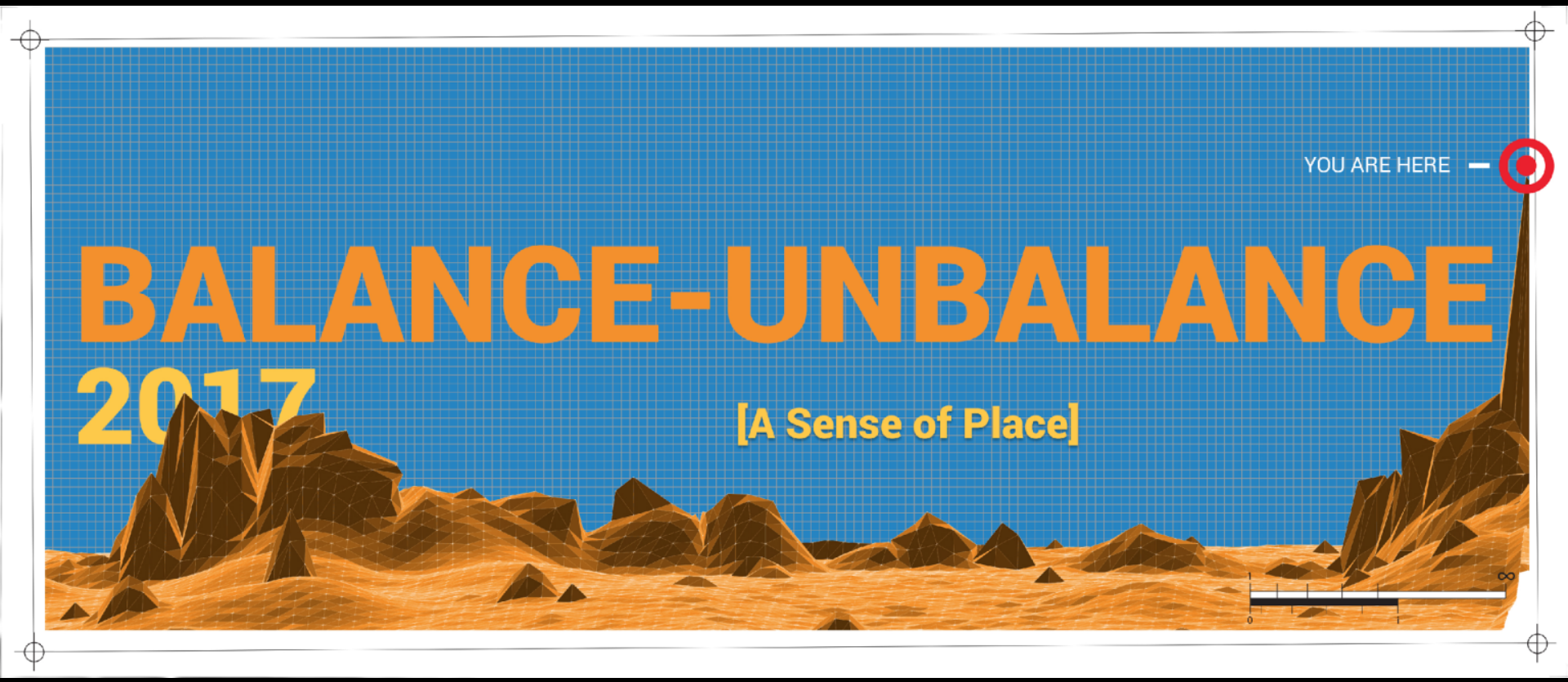


Edward Shanken
Provocations
An International (STEAM) workshop
Plymouth, August 21, 2017

PRELIMINARY QUESTIONS

1. What do ***we*** mean by STEAM?
   a. "we" = LEONARDO/B-U/FACT/iDAT/
      Planetary Collegium Int'l post-sec researchers

2. How is that similar/different to other definitions (K-12)?
   a. Every Student Succeeds Act (ESSA), 2015
   b. US congress => H.R.3344 - STEM to STEAM Act of 2017

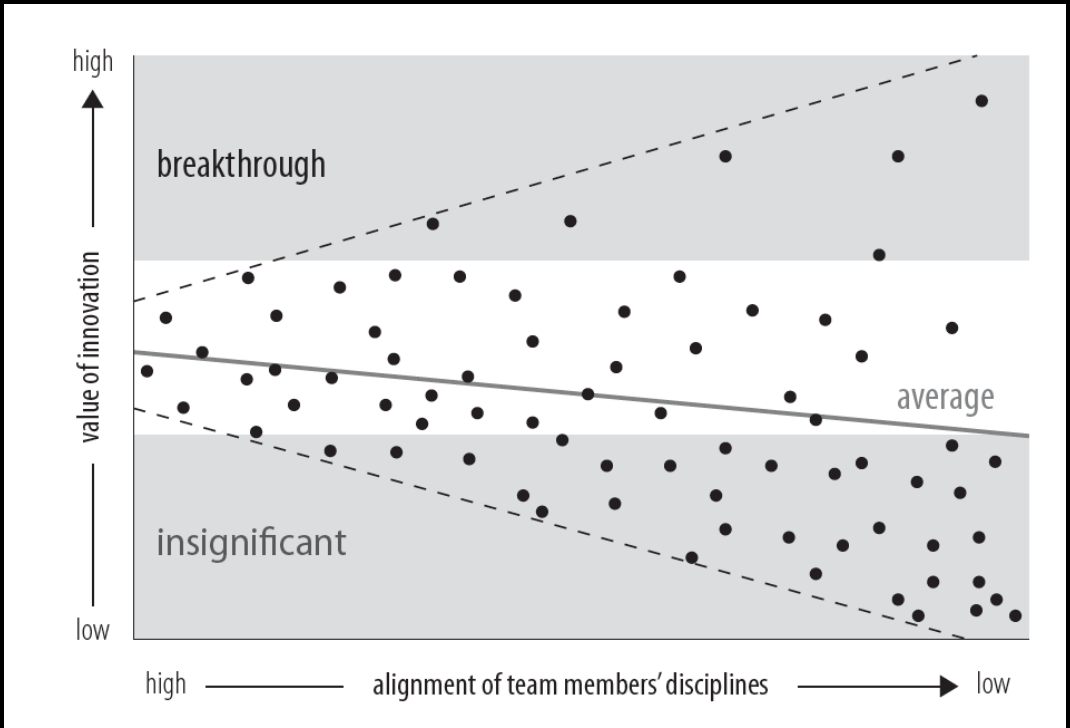
3. Can we harness the steam of (2) K-12 STEAM to further (1) our STEAM?

WHAT IS THE IDEAL GOAL OF STEAM?

I take as an ideal goal of transdisciplinary STEAM research the creation new forms of process, relationship, and understanding that transcend the disciplinary limits of any single field, that push conventional structures of knowledge and yield breakthrough or radical innovations.

- “breakthrough innovations” (Fleming)
- “radical innovation” (Utterback)

Deep Interdisciplinarity and Breakthrough Innovations



"… a creative team [comprised] of very similar disciplines … will be unlikely to achieve a breakthrough."

One comprised of "very diverse disciplines is more likely to achieve breakthroughs – but will also produce many more low-value innovations"

- Lee Fleming, "Perfecting Cross-Pollination," *Harvard Business Review,* Sep 2004.

Radical Innovation

SymbioticA (UWA) and
Steve Potter's Lab (GA Tech)
MEART - The Semi-Living Artist
MEART = Multi Electrode array + ART

Radical innovations often synthesize well-known components in unintended ways.

However, inventors often do not know or poorly understand the interdependencies between the components.

A high degree of uncertainty surrounds these new combinations – most fail, but some reveal unforeseeable usefulness.*

- James Utterback, *Mastering the Dynamics of Innovation*, 1996

* and their utility may not be immediately apparent, eg. XEROX/Apple OS

Composer David Dunn awarded US Patent # 9,480,248

Richard W. Hofstetter, Reagan Mcguire, NAU co-inventors

GENERAL ARTICLE

Entomogenic Climate Change: Insect Bioacoustics and Future Forest Ecology

David D. Dunn and James P. Crutchfield

Forest ecosystems result from a dynamic balance of soil, plants, insects, animals and climate. The balance, though, can be destabilized by outbreaks of tree-eating insects. These outbreaks in turn are sensitive to climate, which controls precipitation. Drought stresses trees, rendering them vulnerable to insect predation. The net result is increased deforestation driven by insects and modulated by climate.

For their part, many species of predating insects persist only to the extent that they successfully reproduce by consuming and living within trees. Drought-stressed trees are easier to

others. (Figure 1 gives a schematic view of the components and interactions that we consider below; cf. Field [1].) How are we to understand the individual views as part of a larger whole? In particular, what can result from interactions between the different scales over which insects, trees and climate adapt?

Leonardo 42:3 (2009)

"Use of acoustics to disrupt and deter wood-infesting insects and other invertebrates from and within trees and wood products."

K-12 STEAM Education in the US

"Every Student Succeeds Act (ESSA)" becomes law - Dec 15, 2015

Reauthorized US federal K-12 education law initiated in mid-60s (most recently "No Child Left Behind, Jan 2002.)

ESSA Includes key amendments offered by Rep Suzanne Bonamici (D-OR):

"(I) programs and activities that support educational programs that integrate multiple disciplines, such as programs that combine arts and mathematics; or

"(vi) integrating other academic subjects, including the arts, into STEM subject programs to increase participation in STEM subjects, improve attainment of skills related to STEM subjects, and promote well-rounded education;

Bi-partisan committee: US Representatives Jim Langevin (D-RI), Suzanne Bonamici (D-OR) and Elise Stefanik (R-NY) co-chairs

Congressional STEAM Caucus – 80+ members

H.R. 3344 - STEM to STEAM Act of 2017

Bill amends the STEM Education Act of 2015 by directing the NSF to make grants available to support the design and testing of ***informal STEAM programs*** to improve educational outcomes and promote creativity and innovation.

$\Rightarrow$ Does not fundamentally alter STEM education

What is it ostensibly good for?

1. **Create more scientists**

Problem: US college science majors (2015) only 1% (NCLB not working) vs. Singapore (67%), China (50%), France (47%), South Korea (38%)

"… incorporating art and design into informal STEM education programs will help spur interest and excitement about STEM learning." - Rep. Langevin

2. **Keep American Industry Competitive**

"Art and design have unlimited real-world applications that contribute unique solutions to our everyday lives. They distinguish American products in a global marketplace and offer new models for creative problem solving and interdisciplinary partnerships…. In order to strengthen this pipeline of innovation, we must integrate art and design into the STEM education fields, turning STEM to STEAM."

(Congressional co-chairs statement accompanying the announcement of STEM to STEAM Act of 2017)

1. Because of the challenges of recognizing the potential impact of breakthroughs, we must develop compelling rationales for the importance of such research as an engine for innovation.

1. We must support genuine STEAM education at all levels of education, not just “informal STEAM programs” that are ancillary to what happens in the classroom.

1. We must figure out how to interface K-12 STEAM education with post-secondary STEAM education.

1. We must support and become more adept at recognizing STEAM research that is not focused on developing marketable commodities but that contributes to new forms of process, relationship, and knowledge.