LEVERAGING PHENOMENA* FOR USEFUL PURPOSES**

- PHYSICAL (e.g. Photoelectric Effect)
- CHEMICAL (e.g. Catalysis)
- GEOLOGICAL (e.g. Groundwater)
- BIOLOGICAL (e.g. Bioengineering)
- SOCIAL-BEHAVIORAL

*And systems, devices and tools- and combinations thereof
**Including the discovering of new phenomena

Paraphrased from Brian Arthur (2008)

Convergence

Increasing complexity
Materials, Energy, Knowledge: Only the latter has the property that the more it is consumed the more is created (not my remark)

**Exponential**, if the technology speed is proportional to it

\[
\frac{\Delta A}{\Delta t} \approx \lambda A
\]

Faster than exponential (**singularity**) if it is proportional to a higher power \((n>1)\)

\[
\frac{\Delta A}{\Delta t} \approx \lambda A^n
\]
Convergence

ENGINEERING + X

Where X is anything*!

E.g. Media, Medicine, Entertainment, Biology, Education,…

Three pathways:

E => X (Engineering Empowers X)
X => E (X empowers Engineering)
EUX (Engineering and X comingle)

E and X can be vectors
*Increasingly human-centric
CONVERGENCE CHALLENGES

“Culture wants to be enduring and prevailing”

from Antonio Damasio’s “The strange world of things” (2018)
Skills and Knowledge (+ Mindsets)

From Ortiz et al.
THE FIVE MINDSETS OF CHANGE TO THRIVE IN TODAY’S WORLD

1. **HUG THE EXPONENTIAL**
   Superb Technical Skills and Knowledge to Lead the Exponentially Changing Technology

2. **ENGINEERING +: CHANGE THE CONVERSATION ABOUT ENGINEERING**
   Engineering + X where X is anything (particularly, human-centric)
   Who we are, what we do and what we look like.

3. **INNOVATION IN THE BROADEST SENSE**
   Innovation and Entrepreneurship, to help create the new markets, the new jobs and to design the new self.

4. **THE CULTURAL MIND**
   Cultural Awareness (with culture broadly interpreted), to help thrive in today’s fast changing world.

5. **HEROIC ENGINEERING**
   Awareness of the Impact of Engineering to Society (and the importance of technology ethics).