How to Engineer Technologies to Ensure the Validity of Research Using Them

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CARMA Larry James Memorial Lecture

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Driven to Discover®

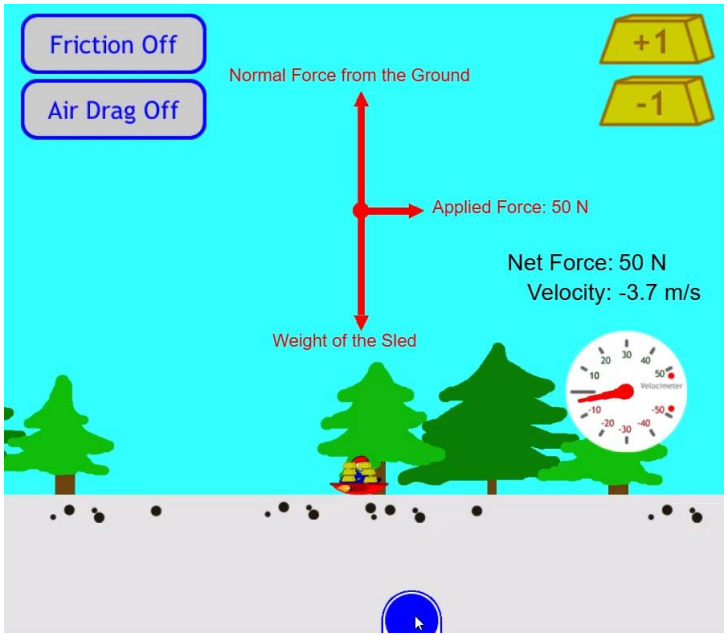
My Entry to the Problem – a Timeline

- **1928**: EL Thorndike claims media don't matter in learning
- **1930s**: Early research finds no media effects
- **1960s**: Schramm shows TV can teach children as well as humans
- **1983**: Richard Clark wrote, "Media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in nutrition."

My Entry to the Problem – a Timeline

- **1994:** Thomas Russell creates *The No Significant Difference Phenomenon*

- **1994:** Robert Kozma challenges Clark's position with a famous example



My Entry to the Problem – a Timeline

- **2006:** Sitzmann releases a study on workplace training, *The comparative effectiveness of web-based and classroom instruction: A meta-analysis*
- **2010:** Arbaugh releases *A review of research on online and blended learning in the management disciplines*
- **2010:** US Department of Education release *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies*

Conclusion?

- All this research appeared to be a massive waste of time and resources.

- What bothered me most:
  - RQ: “Is online less/as/more effective than traditional instruction?”
  - The more reasonable question seemed to be “How?”

How Would You Stack the Deck?

vs.

?

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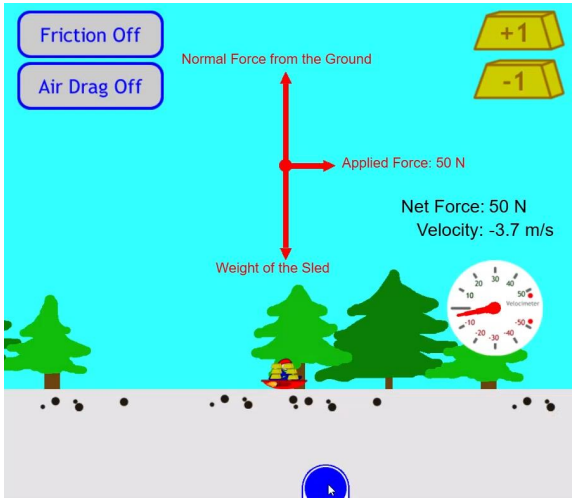
vs.



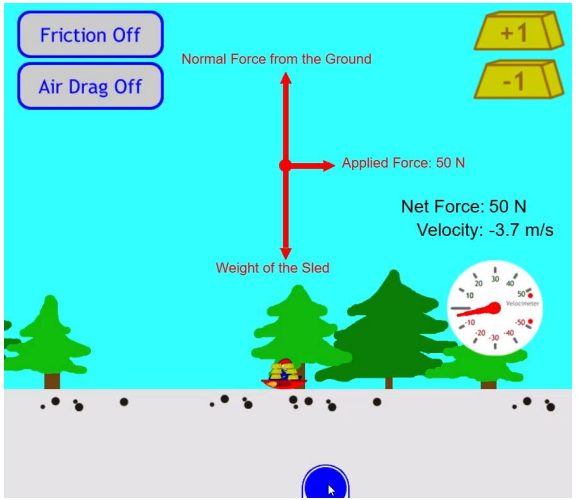
How Would You Stack the Deck?

vs.

```
t= 0.0s | v= 0.000 m/s | a= 0.000 m/s²
F_ext=  0.00 N | F_drag= -0.00 N | F_fric= -0.00 N | F_net=  0.00 N
W= 19.62 N | N= 19.62 N
```

This Example Seems Obvious, But…

vs.



These are both technologies.

Roots Are In an Old Problem

- Cooper & Richardson (1986): *Unfair comparisons*
  - Comparisons are fair when “the competing theories, factors, or variables are operationalized, manipulated, or measured with equivalent strength” (p. 179)
    - *Procedural equivalence*: “operationalized, manipulated, or measured with equal care and fidelity”
    - *Distributional equivalence:* “over equivalent ranges of values in their respective populations”

An Organizational Example

- A convenient organization has shifted from hybrid work to mandatory work-from-home (return to office). What is the expected effect of such shifts?
  - *Procedural equivalence*: What else has changed over the same interval? (a *research design* challenge)
  - *Distributional equivalence:* Is this operationalization of RTO prototypical of the population?

Distributional Equivalence of RTO

- Potential, unmeasured, higher-level moderators
  - Company-specific policies, location, or context that more greatly influences in-person vs. online
  - Competence of technical implementation of WFH
  - Provision of WFH supports and quality of those supports
  - Supervisor support/training for WFH

Another Non-Tech Example

- A convenient organization is allowing you to study their team processes. You want to study predictors of team effectiveness.
  - What covaries with team effectiveness, both measured and unmeasured?
  - What team coordination software is being used, and how does it influence team processes?

Landers & Marin (2021)

- Four eras of technology sophistication in most organizational research literatures
  - **Technology-as-Context**
  - **Technology-as-Causal**
  - **Technology-as-Instrumental**
  - **Technology-as-Designed**

Landers, R. N. & Marin, S. (2021). Theory and technology in organizational psychology: A review of technology integration paradigms and their effects on the validity of theory. *Annual Review of Organizational Psychology and Organizational Behavior, 8,* 235-258. https://doi.org/10.1146/annurev-orgpsych-012420-060843

Advice by Era

- **Technology-as-Context**
  - Primary challenge is representation
    i.e., the technological context must be constant

- **Technology-as-Causal**
  - Primary challenge is isolating specific technologies
  - More proof-of-concept than meaningful theory-building.
  - This approach is not recommended.

Advice by Era

- **Technology-as-Instrumental**
  - Similar challenges as the prior era.
  - Still proof-of-concept.
  - This approach is also not recommended.

- **Technology-as-Designed**
  - Where we'll focus.

Design and Engineering

- Building a design and engineering mindset requires stretching.

- Most organizational researchers are train as scientists. This comes with certain biases.

Landers (2023)

- **Scientific** approach
  - "I can find the best solution to a problem by consulting past scientific research and adopting "best practices" that have been previously validated."

- **Engineering** approach
  - "I can develop the best product for a given use case by using scientific research as a starting point and then optimizing my product development process to local conditions using iteration."

Landers, R. N. (2023). Fixing the IO Psychology-Technology Interface (IOPTI): Avoiding both IO/Tech and Tech/IO conflict. In T. M. Kantrowitz, D. H. Reynolds, & J. C. Scott (Eds.), *Talent Assessment: Embracing Innovation and Mitigating Risk in the Digital Age* (SIOP Professional Practice Series). Oxford University Press.

More Subtle Differences

- **More subjectivist** viewpoints in *our* science
  - We understand the world through the lens of our own biases, so we must make an effort to mitigate those biases.

- **More objectivist** viewpoints in engineering
  - They understand the world by observing it.

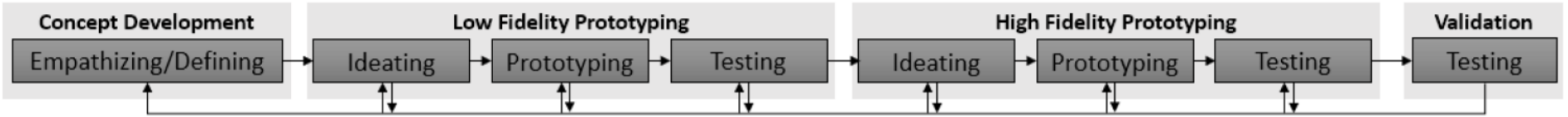
More Subtle Differences

- **We tend toward waterfall design processes.**
  - Identify specific goals and lay out steps to achieve them.

- **Engineers tend toward agile design processes.**
  - Iterate constantly. Freely revisit assumptions and past decisions. Change anything at any time if it furthers our goals at that point.

Landers et al. (2022)

- All products exist within an unending cycle of innovation and iteration.
  - In design thinking, the cycle is: *empathize, define, ideate, prototype, and test*.
  - An applied example:



- Landers, R. N., Armstrong, M. B., Collmus, A. B., Mujcic, S., & Blaik, J. (2022). Theory-driven game-based assessment of general cognitive ability: Design theory, measurement, prediction of performance, and test fairness. *Journal of Applied Psychology, 107*(10), 1655-1677. https://doi.org/10.1037/apl0000954

A Scientist in an Engineer's World

- Define technology more broadly.
  - Any system or process created by humans to assist or replace humans is **technology**.

- Assume all technology is fluid and unstable.
  - When choosing or evaluating technology in your research, consider **what it once was** and **what it might become**.

A Scientist in an Engineer's World

- Seek to understand the **engineering processes** used to create the technologies you rely on.
  - Why were they created? What were the goals of the creators?
  - How were they developed? How many versions have there been? Why?
  - When will the next updates come? How stable are your results likely to be when they do?
  - What changes in either design or use would cause your theory to decay in validity?

A Scientist in an Engineer's World

- **Write honestly about these issues.**
  - It harms the quality and credibility of our science to ignore this.
  - It harms our impact on public opinion and policy when we are studying contexts irrelevant to target populations.

- **Find outlets friendly to interdisciplinary nu**
  - Many of our journals prefer clear-cut answe ing over messiness and validity.
  - Maybe don't publish there!

Thanks for listening!

contact info, journal link, research PDFs

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