Innovation Prototyping

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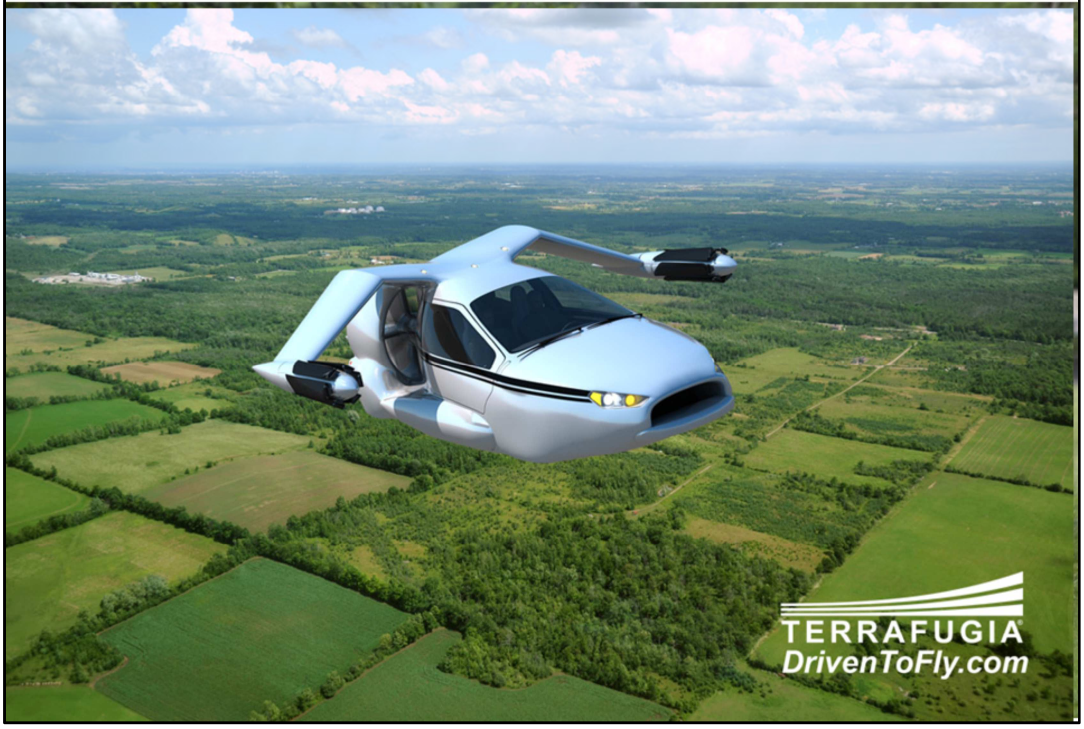
Innovation: it is easy to get caught on the final result



Let me start with what I have come to learn is the curse of innovation.

IT is often easier to get caught up with the final result. Part of the reason us tat by the time an innvoaiton reaches this stage it is easy to indentify ourselves with one of the problems it clearly solves.

Over the last 7 years I have been developing capacity in entrepreneurship and innovation at MIT and wordlwide, in my class at MIT we have accompanied over 120+ new technologies through this process. The key question that drives my work and what I am going to talk about today is the opposite of what this slide reflects.

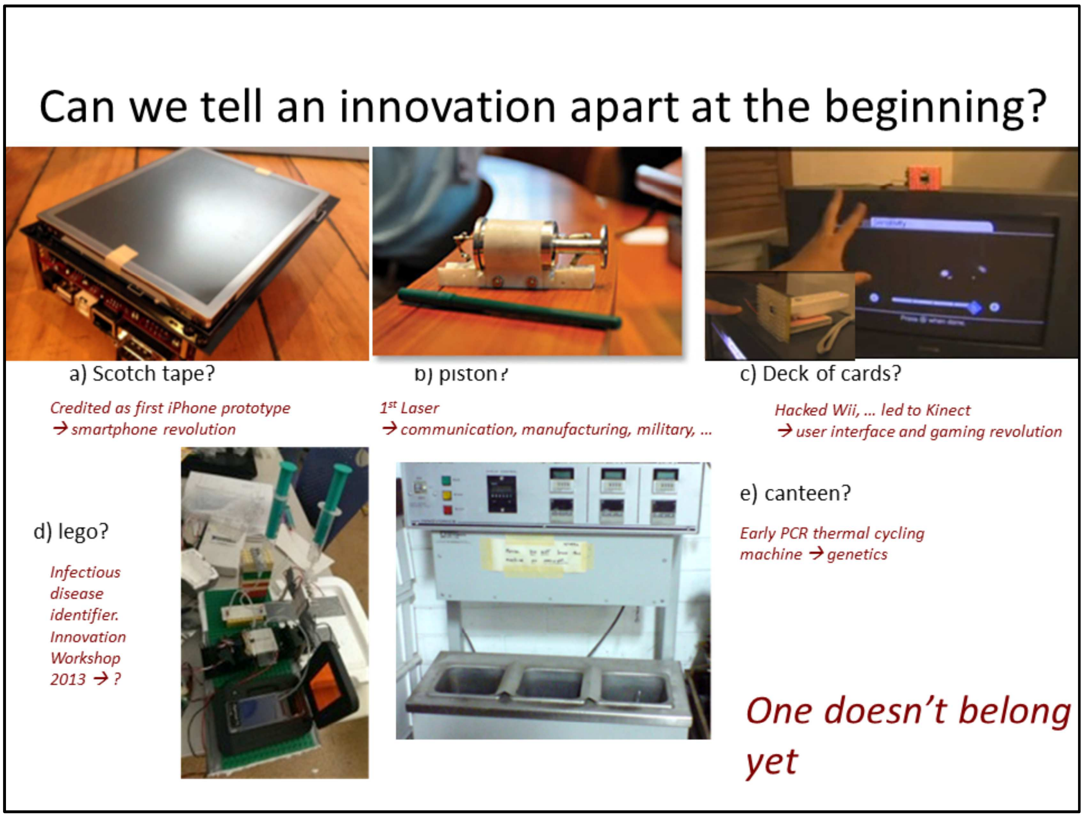
how do innovations actually start?

Users, … pre-Model T. (Ford family).
From PBS documentary American Experience: Henry Ford.
http://video.pbs.org/video/2329934360

Model T

What problem was Ford aiming to solve when he started?
Which (how many) did he solve?
Notice the innovation here was not the car, which was by then a luxury product, but a car that could be assembled in a production line!
What went on between the two pictures?

Would we have been able to recognize the impact/problem solved by inspection of Ford's first prototype?



This is a problem I have queried people around the world. This is one of the exercises I use in my queries

I claim that these 5 pictures are pictures of the first versions of an innovation
In class I would hold a vote about which of these pictures does not belong in the list.
Results are all over the place. Let me show you what they are.

At its genesis, nothing about the innovation seems to be new

- *"One of the things I at least attempted to do and I did turn out to be successful was to use things that were already around. [...] if I had to develop a special lamp that would be a whole other research project, if I had to figure out a new kind of crystal [...] so I had a crystal that not only can be found in nature it can be produced very pure for industrial use [..] I was able get a hold of some rubies, just ordered them, bought them and had them cut, the lamp I could buy [off a photography catalog] and the rest of it was simple machining."*

Interview of Dr Maiman (inventor of first laser) circa 1990

Innovation $\stackrel{def}{=}$ novelty with impact

Technology could be enabling any

Let me zoom into the story of one of these.
Shockingly, nothing about the first laser was new.
- No single part, that is
- Not even first application (replacing scalpel in clinical eye surgery research)

It still took ~20 years for the laser to find its first mass market application (Barcodes)
- In the meantime, however, academia experimented with lasers in all kinds of contexts.
- Meaning these technologies do not sit idle for 10-20 years, they simply do not get to society until society has caught up with the knowledge required to master them into products, infrastructure, or services at the right scale.
- Which seems to imply that for a long time receiving the right education first was a prerequisite to playing with these technologies.

The genesis of these innovators share a few common characteristics

- A hunch of a ***problem*** seeds the process.
- Operating with the problem at the right **scale** enables experimentation ***through trial and error***.
- Understanding of the problem emerges from interaction with ***mostly existing parts*** and with a ***community***.
- Ultimately the innovation prototype evolves into a vehicle to ***scale up the solution to its community***.

None of the innovators was considered a subject expert matter while they were at it, only after.

“Innovating”: the opportunity

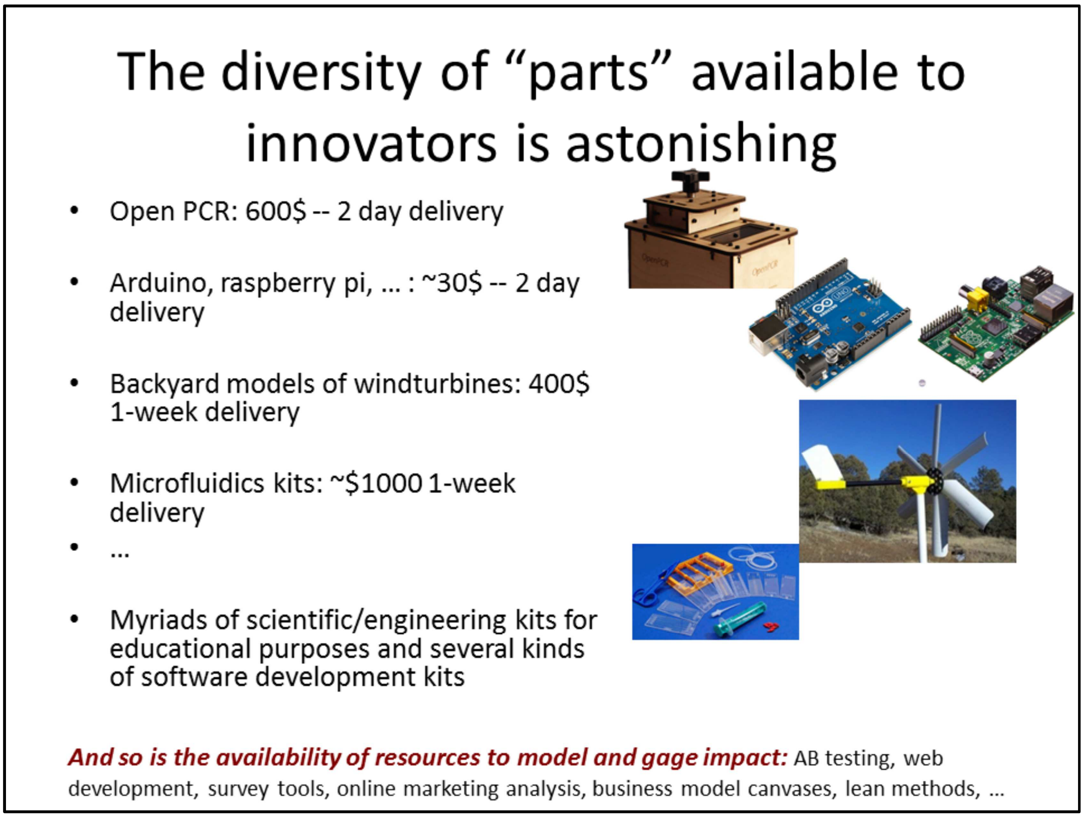
The stories behind these innovations motivate an opportunity to approach innovation dynamically, by ***its practice as a sum of skills*** that go beyond technology or management.

This opportunity has only become possible recently.

The Internet has brought about many changes since the genesis of the laser

- ***Information and knowledge are vastly more available***
  - Free Open Courses online, MOOCs, open access publications, …
- ***Communities are more tightly linked globally***
  - E.g. Social media, Instructables, Arduino community, usenet,, maker movement, …
  - And more receptive to innovation locally.
- ***Parts are more available***

All three, access to information and knowledge, to a community, and to parts with which to experiment quickly were critical to the Laser, Kinect, Apple Computer I, …



This is a quick example of the parts an innovators may get delivered to their home in about a week.
Given this abundance, The question may no longer be, what do I need to become,

But rather:

What problem would I like to work on? What should I do?
What should I put together to start learning about the problem?
Who can I work with? Which is the right community?
Who can make us all smarter about the problem?

There is an opportunity to approach Innovation as a learning process

we learn the problem we are solving

- We can bring ***real-world problems at a table scale***
  - Scale enables quick failure and a broader form of trial and error.

- We can ***query and refine a real-world problem quickly and iteratively*** at that scale
  - using a set of parts to probe nature and inquiry to probe society.
  - Acquiring new skills, team members, and knowledge as we go.

- We can ***learn how to scale back up*** a *solution*, a means to *validate the solution*, or a tangible demonstration of the *problem*
  - Translating risk into uncertainties

These are the characteristics shared across the stories of the innovations we outlined earlier.

Luis Perez-Breva: Prototyping Technology Innovations — Tinkering, reasoning, and experimenting: Innovation is a process.

October 2, 2012 – 3:13 pm

MIT Lecturer Luis Perez Breva

Some people think that the first step of innovation is asking for $10 million. We have grown accustomed to the idea that landing that kind of money from a granting agency or a venture fund is a prerequisite to execute on an idea for a new technology or market —or for that matter, even come up with a good idea in the first place.

No wonder we see gaps.

Last month at MIT the participants in the SkTech/MIT Innovation Workshop 2012 demonstrated there is another way to get started.

Acknowledgements

Innovation Prototyping Lab members

Bryan Hasslam

Katey Lo, PhD

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Charles Cooney, William Lucas

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http://goo.gl/8oJhK

WE DID IT IN THE INNOVATION WORKSHOP (2012, 2013, AND 2014)

It seemed as though a classroom was a befitting environment in whgich to test this. We developed a new kind of experiential education class and introduced several new concepts like an innovation prototyping lab, innovation prototyping kits for technology and impact, notions on the tangibility of problems and the process to operate on the scale of problems,

Teams came up with all kinds of solutions: prototyped smart grids at a table scale that proposed a academia-industry partnership for research, machine vision systems to expedite inventory management, location based systems to monitor traffic inside conferences for marketing purposes, and genetic systems to identify infectious diseases.

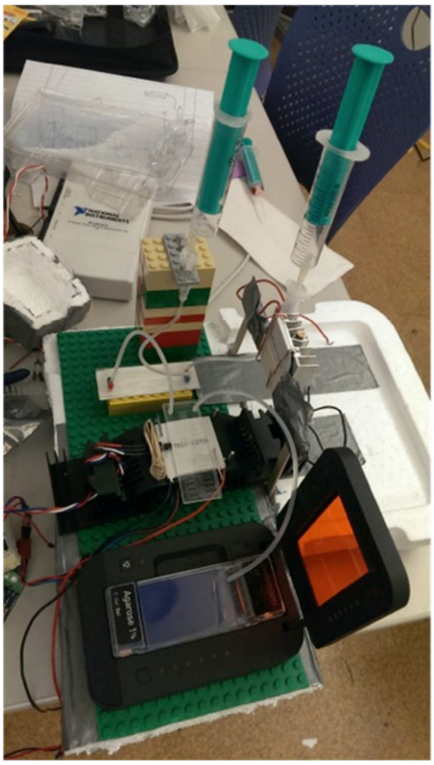
You may find more about what we did in the link above but in the interest of time let me jump to the results.

The workshop in numbers

- In under two weeks, the average team spent under 1000$ and
  - refined their target problems 6 times,
  - iterated over 5 prototypes of technology and impact
  - and reached out to 20+ people.
- ***All teams walked out with a well defined project with clear next steps to target scale.***

- ***Highlight:*** Student entrepreneurial and innovation intent (self-efficacy) grew by 50%.

The strategy we followed to assess the workshop, the work that followed to analyze and interpret the results, and the emerging understanding of experiential learning and innovation prototyping as a measuring apparatus for innovation prototyping will be explained in two upcoming publications co-authored with William Lucas.
Initial results published in Triple Helix 2014 conference



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Summary: The process we have seen today goes beyond technology

Innovations that thrive solve a real world-problem

Innovators cannot possibly be recognized experts (yet) at the innovation they are yet to produce.

Innovation as a learning process:

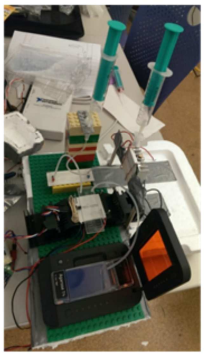
- A hunch of a problem
- An iterative process to make the problem tangible
  - Interacting with mostly existing parts
  - And interfacing with an already existing community
- Learning to be wrong
  - Unafraid of trial and error about parts, community, problem, and impact
  - Learning to acquire knowledge and skills as we go
- Targeted to discover a vehicle to bring an innovation to impact at the right scale.

It builds on two seemingly contradictory statements that motivates a view of the innovation process as a learning process.

The context of Smart cities shares many of these attributes.

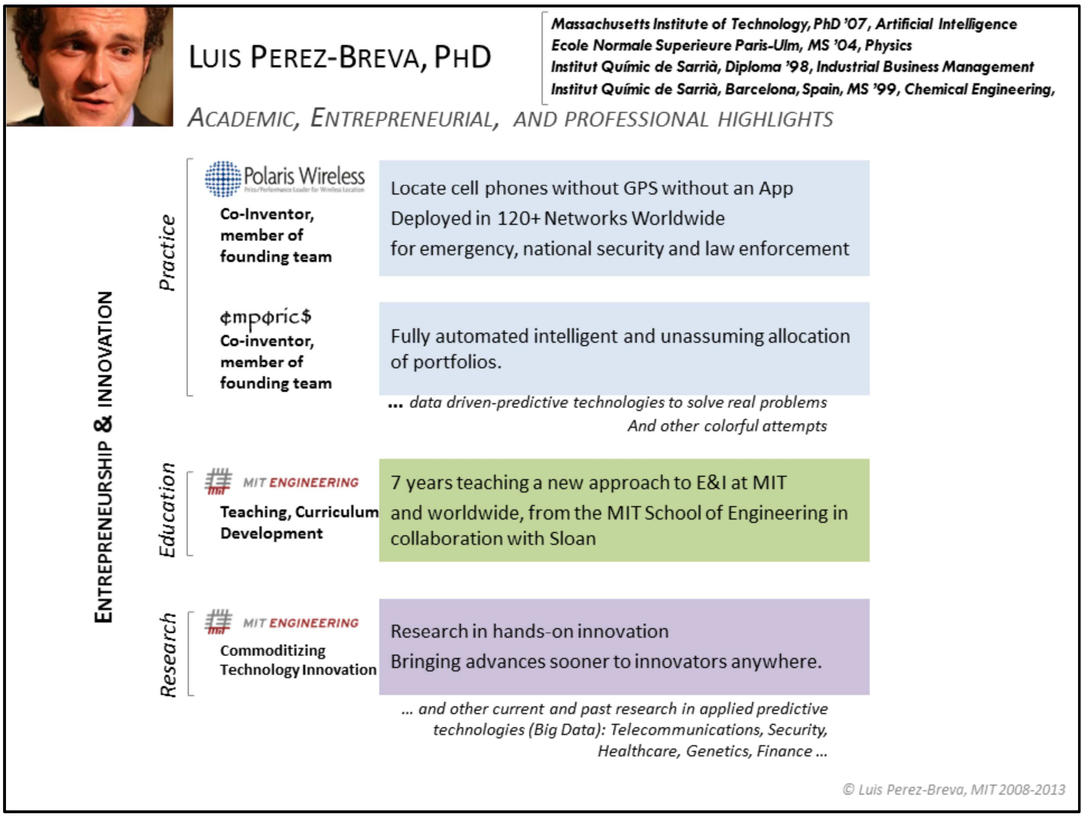
The opportunity for learning does not stop with innovators.

- ***Cities are large systems, symptoms are easy to spot, tangible problem definitions are sometimes elusive.***
  – Cities and policy makers have the means to recognizing the impact of candidate solutions.
- ***Private entities and users in this space already form communities,***
  – Some have the means to develop solutions at the right scale if the problem is clearly revealed,
  – Some already manufacture parts or operate infrastructure critical to the solution.
- ***Refining the problems, is easiest done at a scale that permits rapid cycling through impact and solution.***
  – May this be the job of innovators? Small communities? Small pilots?



- ***how may we enable this kind of massively parallel experimentation?***

THE END



Today in the US, if you have an emergency 'on the move', you will be serviced as if at home…
…even if you can't tell where you are.

7 years developing Innovation and Entrepreneurship capacity worldwide And AT MIT

Over that period in our program at MIT we’ve overseen the translation of over 120+ technologies into fact-based opportunities for impact.

The components of our educational experiment

- We transformed a classroom into an ***innovation prototyping lab***.
  - The more tangible the idea, the higher the value
  - You can prototype an *entire* innovation virtually anywhere

- We conceived ***innovation prototyping kits***: to prototype "anything" for less than 300$/person
  - The first step to innovation is not asking for $X M

- We seeded the process with a hunch of an **open-ended problem**, notions of ***scale***, and strategies to ***acquire information and knowledge on-the-go.***

We asked for a tangible demonstration of a problem, its solution, or how to certify one

The Input

DNA Tsunami

Forget about reading it, what if DNA could talk? Can you probe the flood of DNA surrounding you to sense, interpret, predict, and react to reality?

It is a well kept secret that at the rate at which we shred DNA samples, we might as well think of ourselves as a virus invading the planet. But don't worry, it wasn't just you. In the last 10 minutes you have been showered with DNA from bacteria, plants, animals, other people, and some of your own DNA has boomeranged back.

You might as well start paying attention to it as it might have something to say. Some people have found the key to their ancestry in their cheeks, you might join the wave and become the genetic oracle for your family and friends. They may come to seek your wisdom when in need to fathom if

2-pager with an open problem set-up a description of initial avenues for tinkering, and how to get started with parts and with market discovery.

At the rate at which the price of genetic sequencing is going down we may soon be able to spell all that DNA. Let's not wait until we learn to read it though. You may already be able to tell the meaning apart if you know which question to ask. Perhaps you are on your way to develop a chip to read DNA on the go?

[...]

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The components of our educational experiment

- Foundational Premises:
  - The first step to innovation is **not** asking for $X M
  - The more tangible, the higher the value
  - You can prototype an entire innovation
    - Problem, technology, and impact
    - Virtually anywhere, …
- Resources
  - transformed a classroom into an ***innovation prototyping lab***.
  - A process to **operate with problems at scale and acquire information from parts and people**
  - ***innovation prototyping kits***: to prototype anything for less than 300$/person
- We seeded the process with a hunch of a problem
- We asked for a tangible demonstration of a problem, its solution, or how to certify one

Our Basic Findings

- Innovations start as an assembly of mostly old parts
  - Guided by concrete findings about potential use
- Left alone, new technologies take 10-20 years from inception to first application *(Laser, Phonograph, Radio, Computer, …)*
  - After first application clarifies understanding and cost, experimentation with use is made possible.
  - Many more uses and applications emerge.
- The renaissance of manufacturing and the maker movement are creating new capacity and resources:
  - Single innovators can leverage this capacity at a much smaller scale now than ever before
- Innovation is a learning process
  - Innovators cannot possibly be yet experts at the innovation they are yet to produce.

can we open up this kind of experimentation about innovation to society?

Beyond Technology

- the process above does not make technology central, technology just makes it easier to explain the notions of scale and learning as you go and the peculiar interplay between novelty and old parts

The genesis of these innovations shares a few common characteristics

- At the beginning, there is a hunch of a ***problem***
- The first step is ***bringing the problem down to a scale*** at which experimentation is easier.
  - Identifying existing parts to render the problem ***tangible***.
  - Identifying existing avenues for impact.
- ***Experimentation and trial and error*** at that table-scale guides subsequent refinements of the problem
  - We understand the problem through interaction with ***parts*** and with a ***community***.
  - We acquire new knowledge and skills as needed to progress through iterations
- Ultimately the innovation prototype sums up the results of this inquiry in a vehicle to ***scale up the innovation to society***.

The challenges

- Help new innovators become comfortable with a broader form of trial and error
- Accept that the final innovation will emerge from the process.
- Learn to acquire skills, knowledge, and a team as you go…

Our findings

The genesis of innovations

- innovations ultimately solve a problem:
  - Innovators need a hunch of a well-defined problem to refine.
- Experimentation can happen first at a "table scale"
  - Quicker and inexpensive
  - No new parts needed
  - Value first resides in the combination.
- Innovation involves two processes:
  - Discovery of the problem and Scale up to society

The challenges

Commoditizing Technology Innovation.

Project Summary

- Educational Research Project.
- Larger Objective: Arrive at a **STEM-Friendly** formulation of Innovation
  - Based on developing skills and capabilities to practice innovating.
  - Compatible and not competing with STEM and management perspectives.
- Specific Objectives:
  - Develop and demonstrate innovation prototyping (concepts, Lab, materials for education, research and translation)
  - Evolve a continuous process for technology innovation (as opposed to batch processes)
- Status: 5 months into project, we have developed lab, evolved preliminary apparatus and designs, and have preliminary results.

Agenda

- Foundation of Commoditizing Technology Innovation
  - Basic hypotheses and supporting premises.
  - Emerging design of Innovation as a Learning process.
- Reporting on project build out phase and Preliminary results.
  - New concepts developed around Innovation Prototyping.
  - Preliminary designs and early qualitative results.
  - Results using assessments as a measurement tool.

Main Hypotheses

1. We can accelerate translation of discoveries into precursors of innovation if we focus first on commoditization of the key parts.
   – The biggest hurdle to drive technology innovations towards massive experimentation is waiting until the key components are commoditized one product (or startup) at a time, …

2. Technology Innovation is fundamentally a problem of scale.
   – The real-world problem and the demonstration of a technology advance live at different scales.

Summary

- **This project aspires to develop a STEM friendly connection to innovation.**
  - For all to evolve tangible demonstrations of the real-world problems they set out to solve.
  - To complement Powerpoint as a prototyping tool: with tangible means to prototype the entire innovation and gather real facts about the scale of the problem and its impact.

- **Presented the emerging principles we have developed to define and enable Innovation prototyping**
  - Lab, Kits, Primers, learning process.
  - Innovation as a learning process.
  - Educational and research materials spanning beyond traditional design to capture the open-ended nature of innovation.
- **Showed preliminary evidence that suggests the potential of these materials**
  - to evolve into a **common grammar for innovation across domains**.
  - To evolve into a **new means to diffuse technology advances** and enable sooner societal experimentation on the use of these advances.

- Future Work:
  - Continue to develop Innovation prototyping concepts
    - Complete demonstration of learning abstraction in Innovation prototyping Primers, including development of quantitative assessment strategies, possibly as part of experiential education.
  - Develop a new kit from a recent technology advance that demonstrates applicability as a means to diffuse research for its use.
  - Develop Scale-up and Diffusion aspects of the project

Acknowledgements

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- Charles Cooney
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