

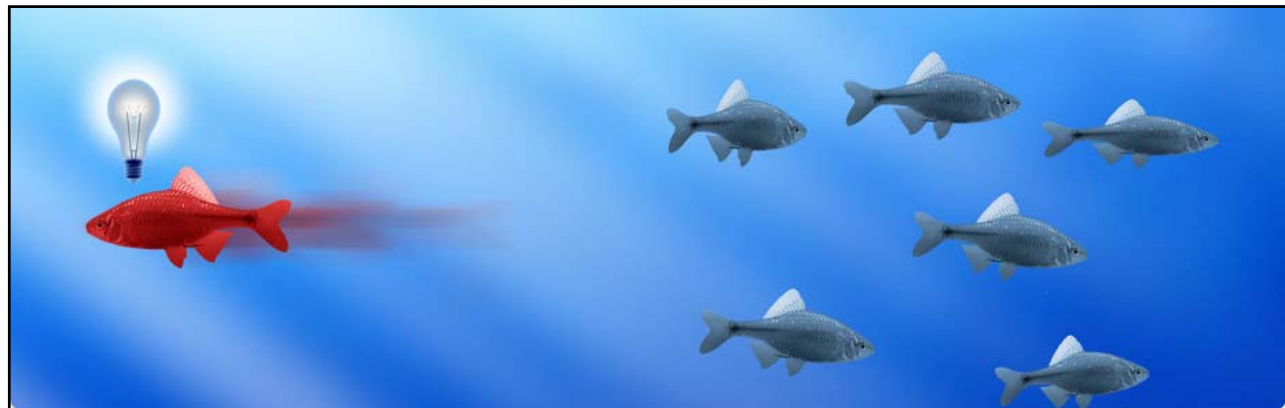


## agenda

- Innovation
- The formula for innovation
- The how – 5 things higher education can do to develop the next generation of innovators
- Concluding remarks
- Q&A

*“Scientists study the world as it is;  
engineers create the world that  
has never been.”*

— Theodore von Kármán



What is innovation?



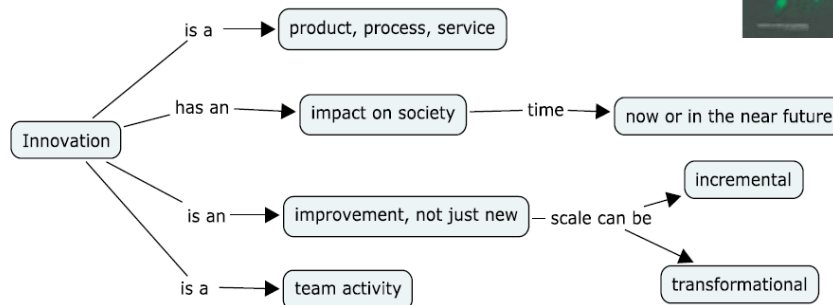
## innovation

- The process of **translating an idea or invention into a good or service that creates value or for which customers will pay.**
- Innovation involves deliberate application of **information, imagination and initiative** in deriving greater or different values from resources, and includes all processes by which new ideas are generated and converted into useful products.

<http://www.businessdictionary.com/definition/innovation.html#ixzz3rtwmErK>



## Characteristics of innovation



Characteristics of innovation.

[http://www.nap.edu/catalog.php?record\\_id=21698](http://www.nap.edu/catalog.php?record_id=21698)



# History of Engineering Innovations

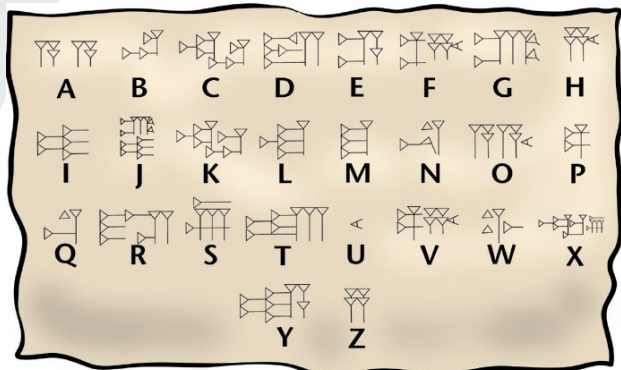


## Pre-Historic Times

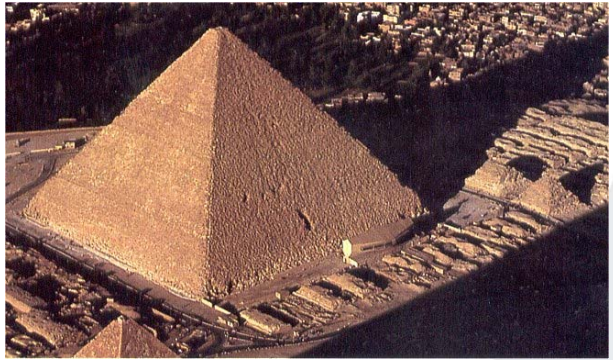




# Ancient Era



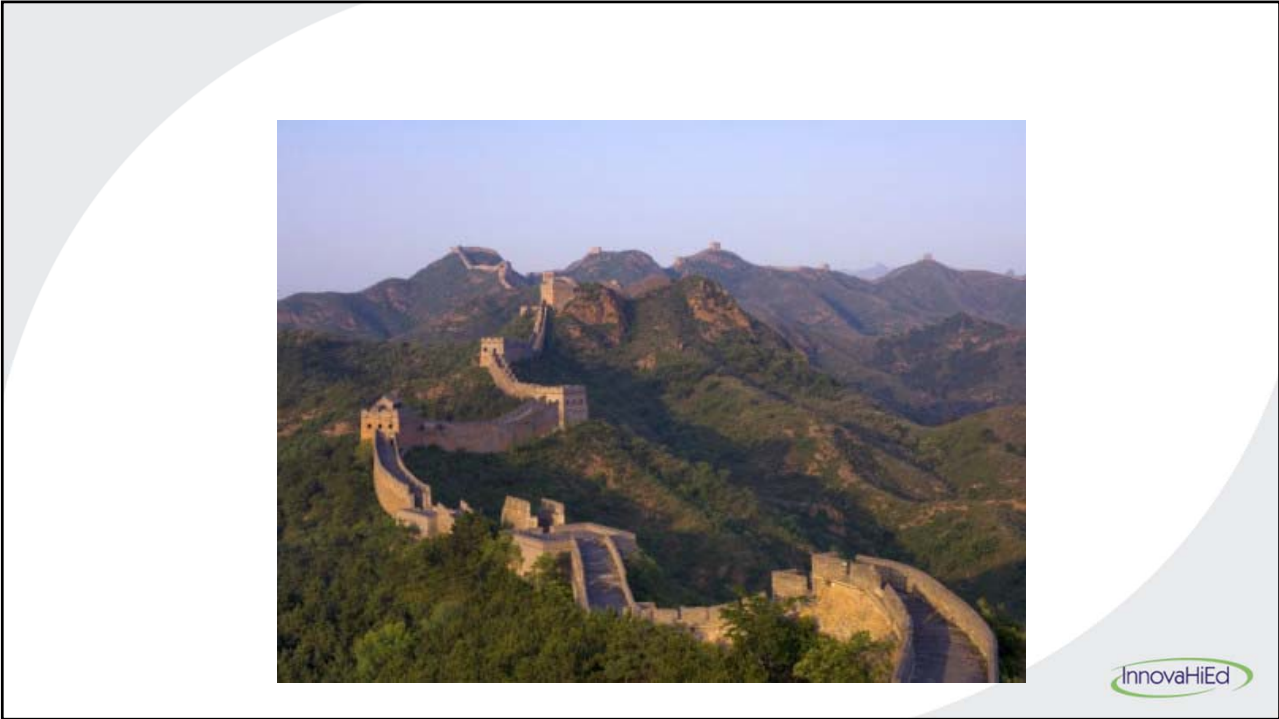
Mesopotamia's First System of Writing



Great Pyramid of Khufu

<https://www.google.com/maps/@29.978152,31.135061,2170m/data=!3m1!1e3>





### Middle Era



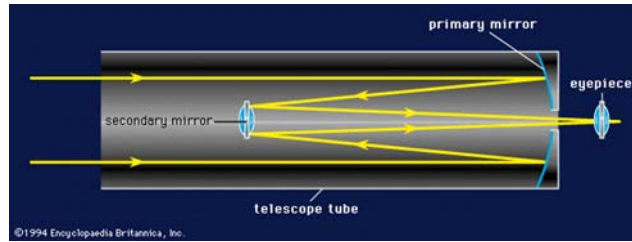
[https://en.wikipedia.org/wiki/Ismail\\_al-Jazari](https://en.wikipedia.org/wiki/Ismail_al-Jazari)

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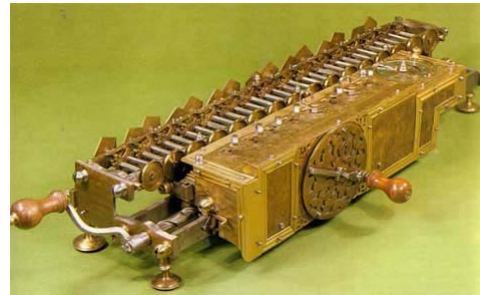
## Renaissance Era



Watt Steam Machine



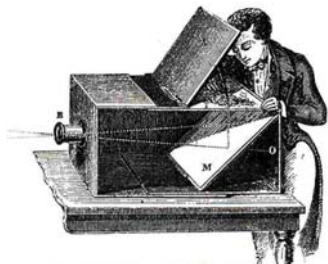
Isaac Newton Telescope



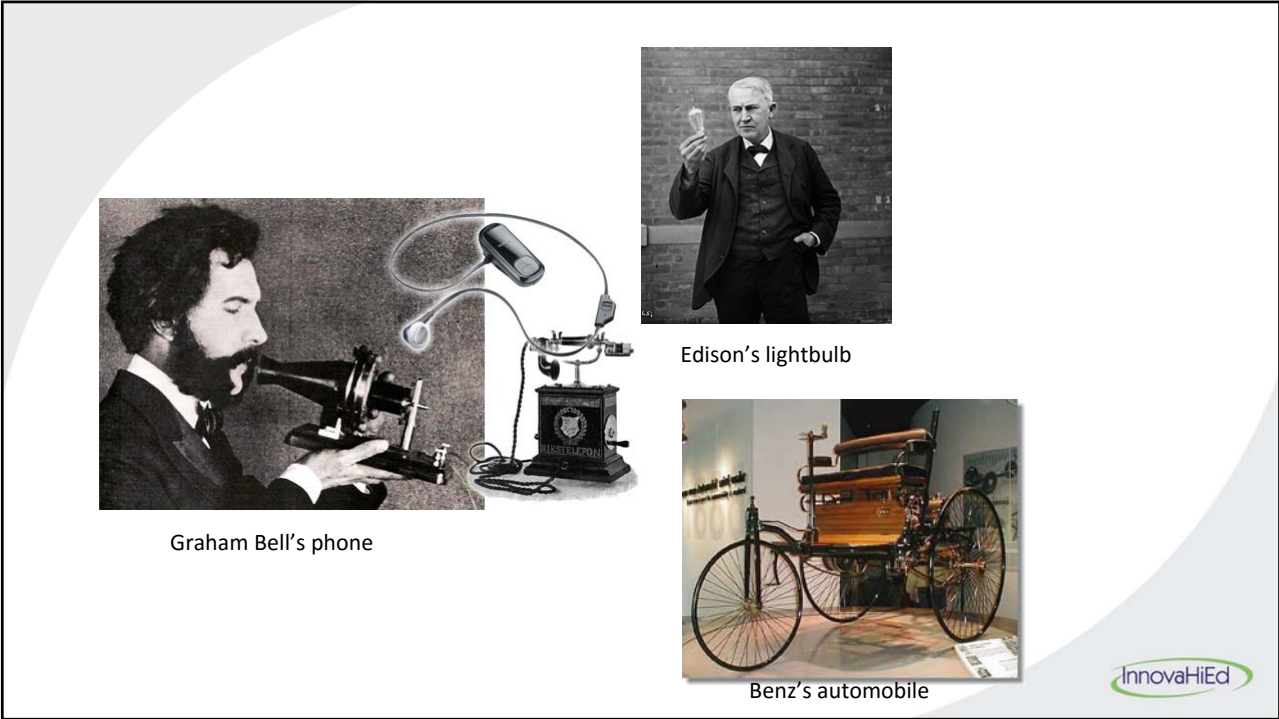
Liebnitz Calculating Machine



## Modern Era











## Hypatia, ~350 ad



- Greek Alexandrian Neoplatonist philosopher in Egypt. As head of the Platonist school at Alexandria, she taught philosophy and astronomy.
- Credited with the invention of the hydrometer.

## The first "computer program" was designed by a famous poet's daughter in 1843

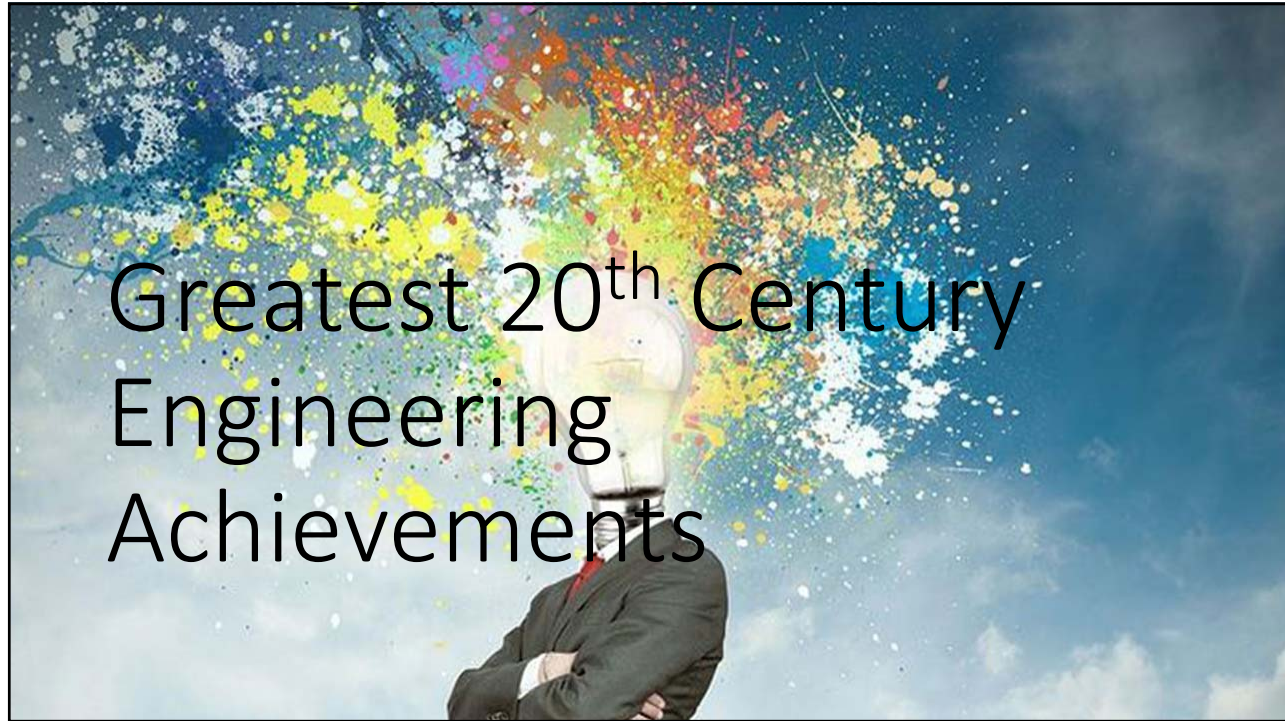
Ada Byron Lovelace, daughter of famous poet Lord Byron, published a paper in 1843 that predicted the development of computer software, artificial intelligence, and computer music.



## Hedy Lamarr

A famous movie actress of the 1930's was also an engineer. Lamarr held a patent on technology which is the foundation for today's advanced wireless networks.





## Greatest 20<sup>th</sup> Century Engineering Achievements

1. Electrification
2. Automobile
3. Airplane
4. Water Supply and Distribution
5. Electronics
6. Radio and Television
7. Agricultural Mechanization
8. Computers
9. Telephone
10. Air Conditioning and Refrigeration
11. Highways
12. Spacecraft
13. Internet
14. Imaging
15. Household Appliances
16. Health Technologies
17. Petroleum and Petrochemical Technologies
18. Laser and Fibre Optics
19. Nuclear Technologies
20. High Performance Materials

<http://www.greatachievements.org/>



## We are already in the 4<sup>th</sup> Industrial Revolution



COMMITTED TO IMPROVING THE STATE OF THE WORLD


### Navigating the next industrial revolution

	Revolution	Year	Information	
<div style="background-color: #f4a460; padding: 5px; border-radius: 10px; width: fit-content; margin: 0 auto;">Humans as Robots</div>		1	1784	Steam, water, mechanical production equipment
		2	1870	Division of labour, electricity, mass production
<div style="background-color: #76c73a; padding: 5px; border-radius: 10px; width: fit-content; margin: 0 auto;">Humans as Innovators</div>		3	1969	Electronics, IT, automated production
		4	?	Cyber-physical systems

<https://agenda.weforum.org/2015/09/fourth-industrial-revolution/>



## When will the future arrive?




COMMITTED TO IMPROVING THE STATE OF THE WORLD

800 technology executives and experts from the information and communications technology sector were surveyed as part of our *Technology Tipping Points and Societal Impact* report

Technology tipping points expected to occur by 2025	Percentage of respondents
10% of people wearing clothes connected to the internet	91.2
The first robotic pharmacist in the US	86.5
The first 3D-printed car in production	84.1
5% of consumer products printed in 3D	81.1
90% of the population with regular access to the internet	78.8
Driverless cars equalling 10% of all cars on US roads	78.2
The first transplant of a 3D-printed liver	76.4
Over 50% of internet traffic to homes for appliances and devices	69.9
The first city with more than 50,000 people and no traffic lights	63.7
The first AI machine on a corporate board of directors	45.2

Source: World Economic Forum, Technology Tipping Points and Societal Impact report, 2015





*“Innovators are people who are real misfits in their field, because they can see across borders, they can see across borders of discipline, geography, all of that. They’re the ones who can make those disparate connections between, say, DNA and a hard drive, and say “Let me make a DNA hard drive.”*

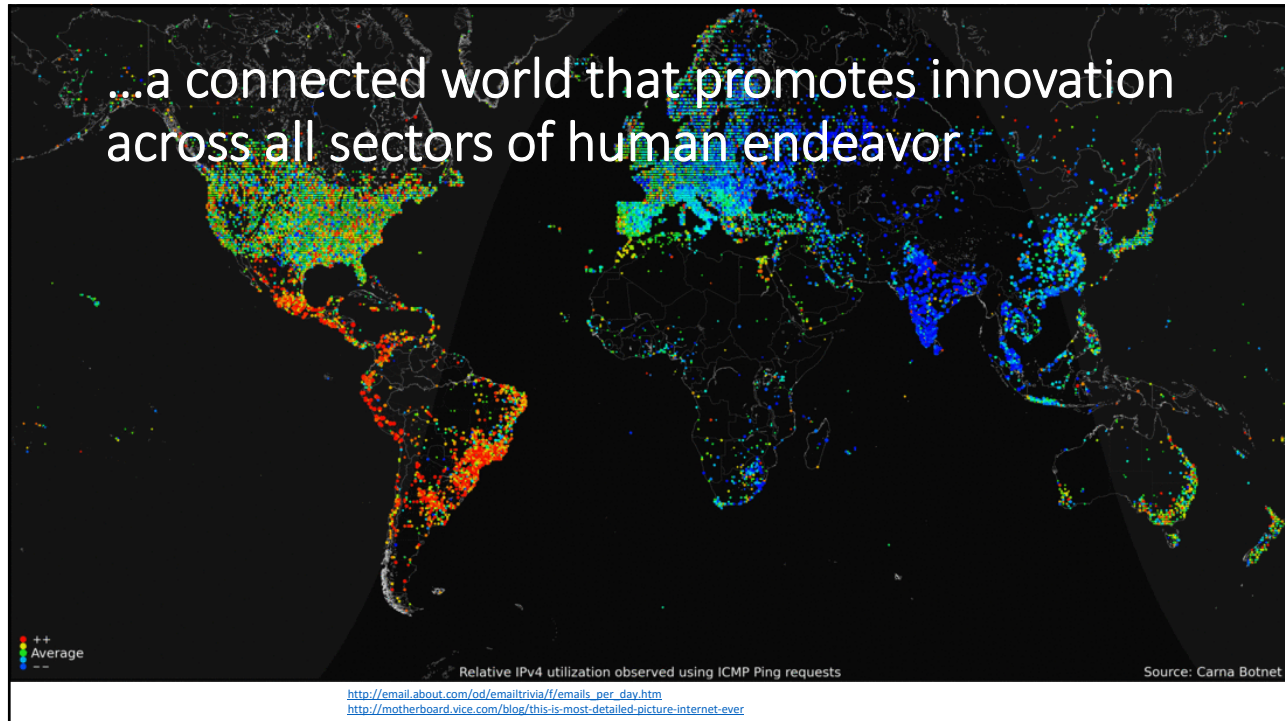
– Nina Tandon



## “VUCA world”

**V**olatile  
**U**nrest  
**C**omplex  
**A**mbiguous

Source: Dr. Bob Johansen, President and CEO of the Institute for the Future

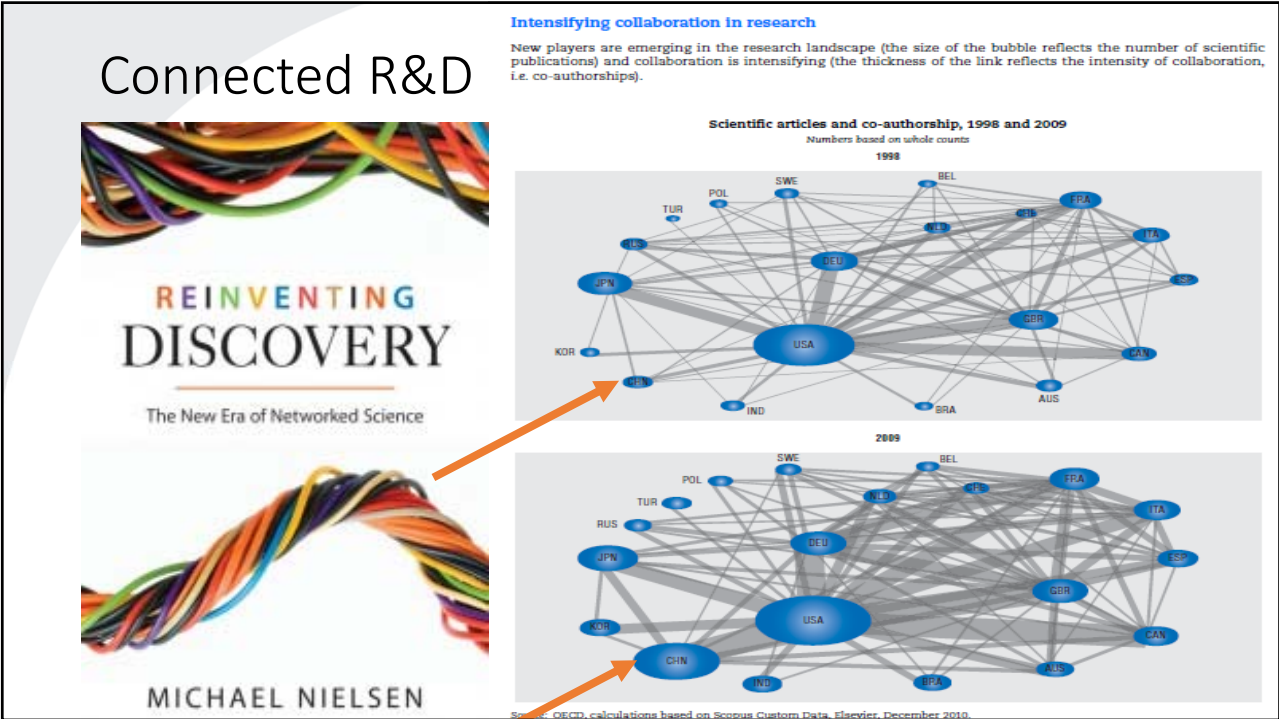


### A highly competitive world

Global Top 10	
	Global rank*
Switzerland	1
Singapore	2
United States	3
Finland	4
Germany	5
Japan	6
Hong Kong SAR	7
Netherlands	8
United Kingdom	9
Sweden	10

Source: The Global Competitiveness Report 2014-2015  
Note: \* 2014-2015 rank out of 144 economies

<http://www.weforum.org/reports/global-competitiveness-report-2014-2015>



## Knowledge economies pillars

- SMET human resources
- Innovation, R&D
- Policies
- CIT Infrastructure



“Whatever their level of development, countries should consider embarking on a knowledge- and innovation-based development process.”

<http://web.worldbank.org/WBSITE/EXTERNAL/WBI/WBIPROGRAMS/KFDLP/0,,contentMDK:21437029~menuPK:1727232~pagePK:64156158~piPK:64152884~theSitePK:461198,00.html>



## Urban economic shifts

2007 – 8/50

2025 – 20/50

**Urban economic clout moves east.**

**World's top 50 cities, ranked by GDP<sup>1</sup>**

**Newcomers in 2025**


- Bangkok
- Beijing
- Chengdu
- Chongqing
- Delhi
- Doha
- Foshan
- Guangzhou
- Hangzhou
- Mumbai
- Nanjing
- Shenyang
- Shenzhen
- Tianjin
- Wuhan
- Xi'an

**Dropouts in 2025**

- Athens
- Barcelona
- Denver
- Detroit
- Hamburg
- Lille
- Melbourne
- Minneapolis-St. Paul
- Munich
- Nagoya
- Oslo
- Rhein-Main
- Rio de Janeiro
- Stuttgart
- Taipei
- Vienna

**Legend:**

- Dropout – included in 2007 but not in 2025
- Top 50 city in both 2007 and 2025
- Newcomer – absent in 2007 but included in 2025



<sup>1</sup>GDP is measured in dollars, using market exchange rates in 2007 and predicted real exchange rates in 2025. Data points on map and in lists refer to metropolitan areas rather than specific city jurisdictions, aggregating neighboring cities when appropriate (eg, Rhein-Ruhr in Germany; Los Angeles, Long Beach, and Santa Ana in California; or Mumbai and Thane in India).  
 Source: McKinsey Global Institute

McKinsey Quarterly, September 2011 Newsletter





“Our future competitiveness depends on a skilled workforce of engineers and innovators.”

~Dr. Ray O. Johnson,  
SVP & CTO, Lockheed Martin

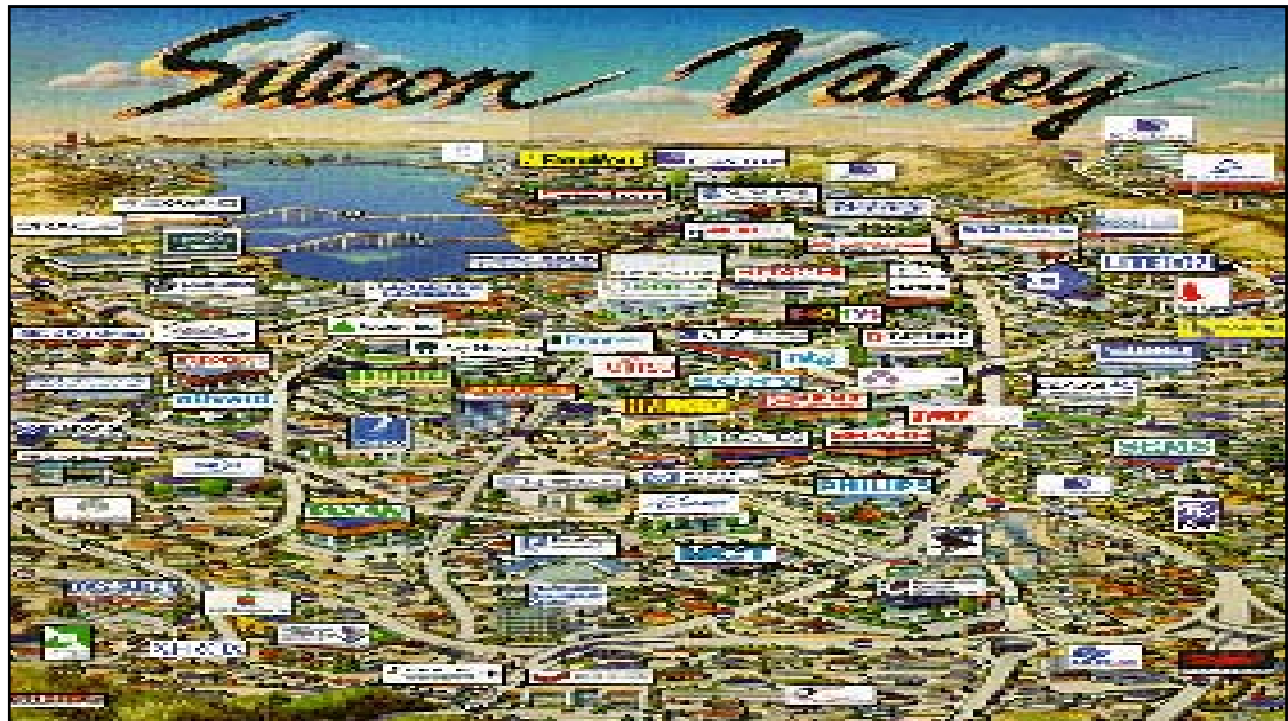


## Formula for innovation @ macro level

- Multi-disciplinary, multi-national, multi-stakeholder teams
- Multi-disciplinary curriculum (SMET + liberal arts + management, social sciences, etc.)
- Rule of law, society embracing mobility, policies
- Infrastructure



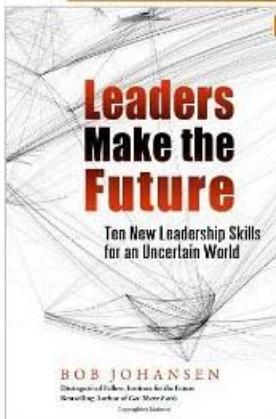
Adapted from : WBI & Innovation 100, WEF 2008







## Formula for innovation @ **micro** level

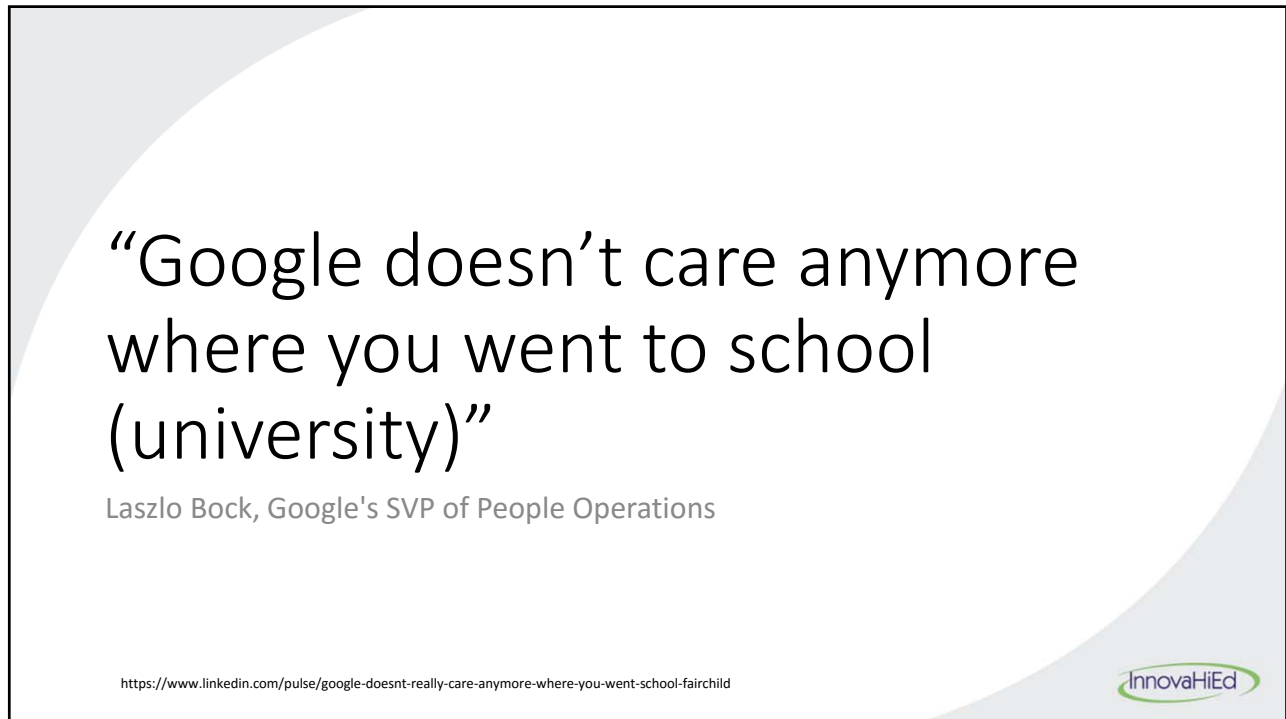


Adapted from Dr. Bob Johansen, President and  
CEO of the Institute for the Future  
\*Daniel Goleman

- Mobility — ability to work in large groups; talent for organizing & collaborating with many people simultaneously
- Influency — ability to be persuasive in multiple social contexts & media spaces; understanding that each context & space requires a different persuasive strategy & technique
- Protovation — fearless innovation in rapid, iterative circles
- Emerginsight — ability to prepare for & handle surprising results & complexity
- Cooperation Radar — the ability to sense, almost intuitively, who would make the best collaborators on a particular task
- .....







## Engineering competencies employers seek (2015)



<http://naceweb.com/about-us/press/class-2015-skills-qualities-employers-want.aspx>

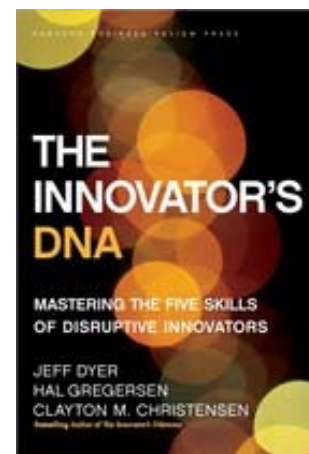
- leadership
- the **breadth** a team structure.
- written communication skills
- problem-solving skills
- strong work ethic
- analytical/quantitative skills




## The 5 skills of disruptive innovators

How do innovators come up with new ideas?

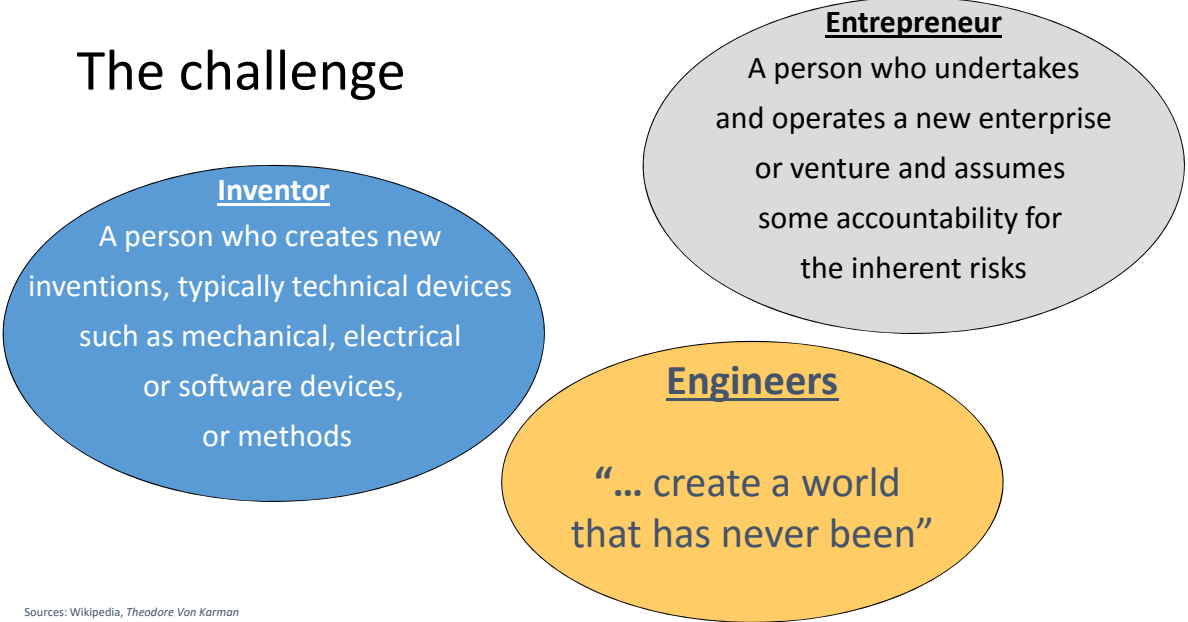
- **Associating**
  - Connecting the dots, visualizing problem & solution
- **Questioning**
  - Break out of the status quo; consider new possibilities
- **Observing**
  - Detect small behavioral details that suggest new way of doing things
- **Networking**
  - Gain radically different perspectives by connecting with people from diverse backgrounds
- **Experimenting**
  - Relentlessly try on new experiences



# how can we develop the next generation of innovators?




## The challenge



- Inventor**  
A person who creates new inventions, typically technical devices such as mechanical, electrical or software devices, or methods
- Entrepreneur**  
A person who undertakes and operates a new enterprise or venture and assumes some accountability for the inherent risks
- Engineers**  
“... create a world that has never been”

Sources: Wikipedia, Theodore Van Karman



# How can we educate?

**Inventor**  
A person who creates new inventions, typically technical devices such as mechanical, electrical or software devices, or methods.

**Entrepreneur**  
A person who undertakes and operates a new enterprise or venture and assumes some accountability for

**Engineer  
Inventor  
Entrepreneur**

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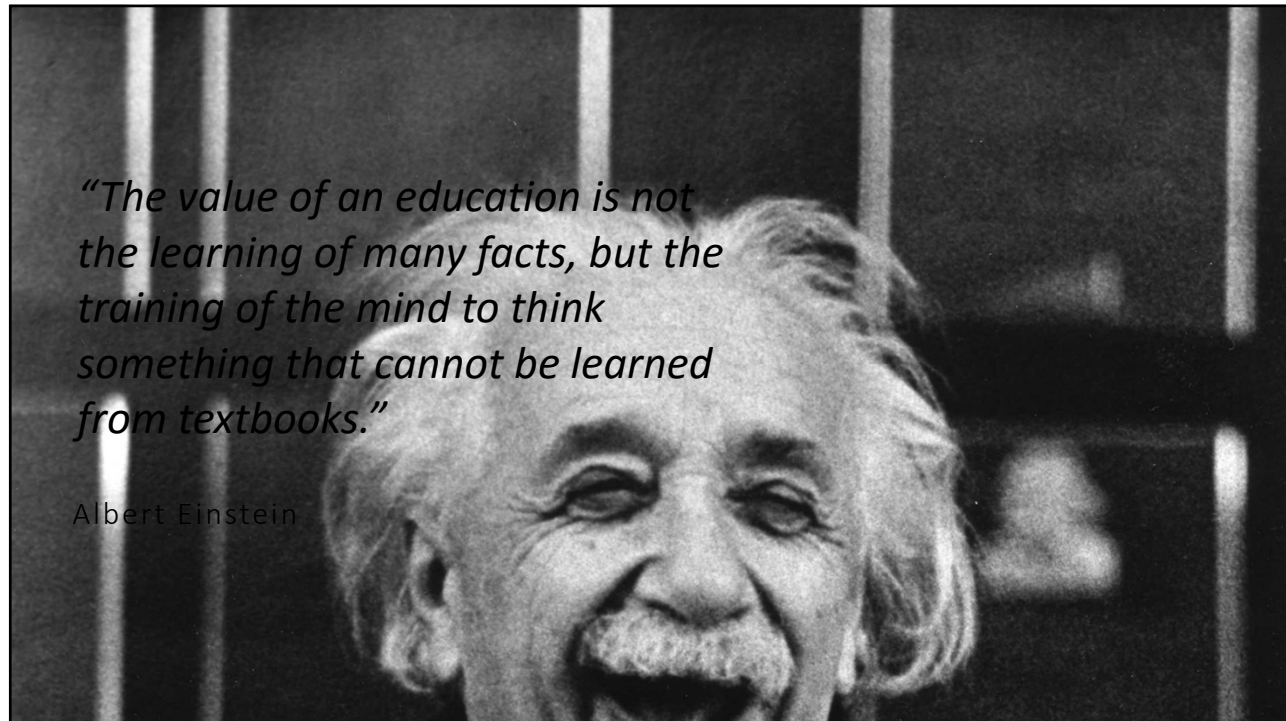
Alfred Nobel

InovaEd

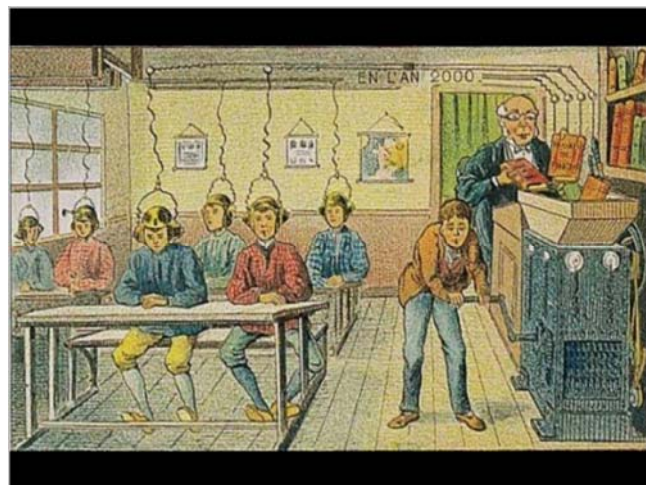
*“In the spirit of honoring traditions, universities hang on to past practices imperiling their future.”*

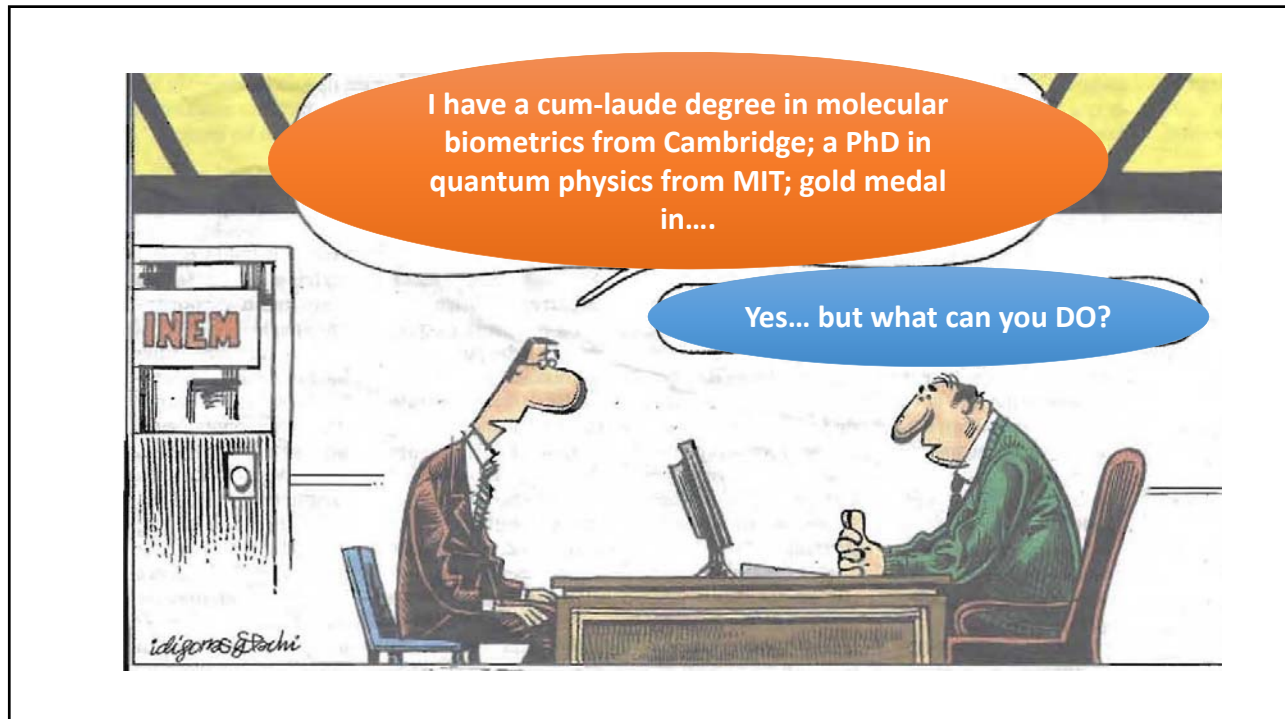
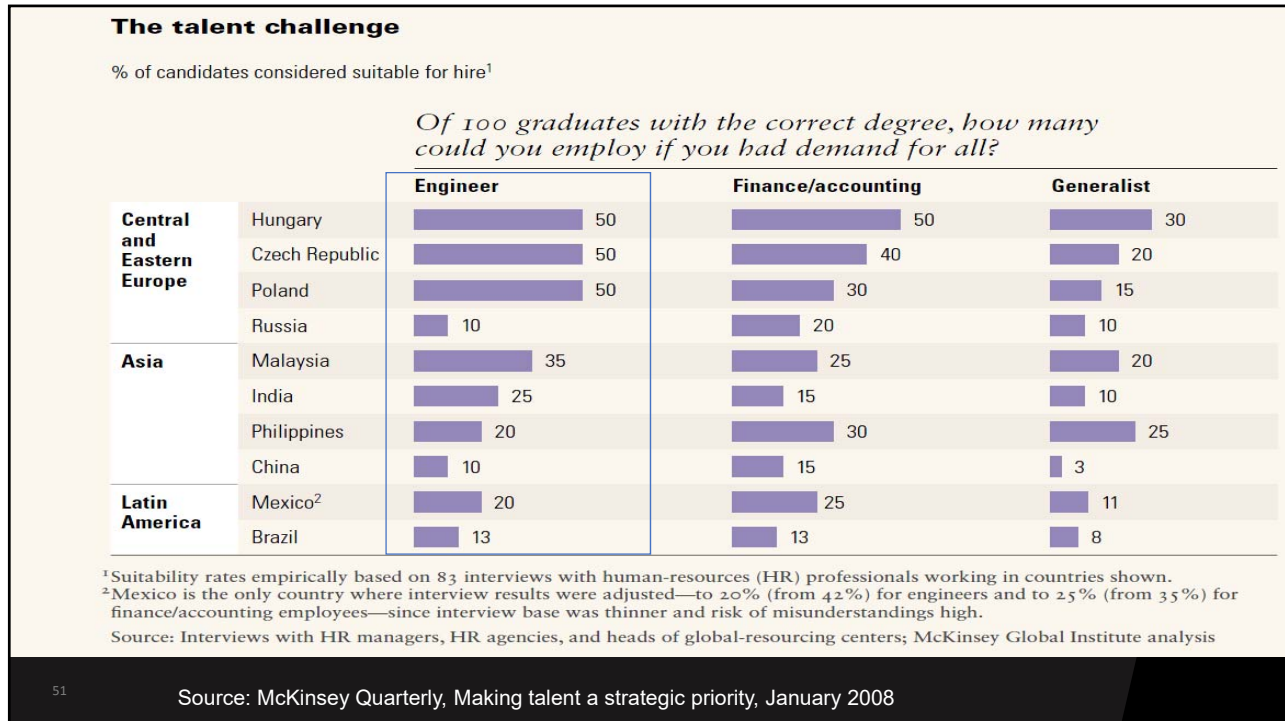
Clayton Christensen  
Harvard University





We are teaching  
21<sup>st</sup> century  
students with  
20<sup>th</sup> century  
curricula in  
18<sup>th</sup> century  
classrooms







TPS (think-pair-share) 5 min

Make a list of initiatives/activities you are doing to promote the development of innovators in your university.





5 things  
we can do...

*“Make innovation & entrepreneurship education & practice a signature feature of the entire university, create a culture everyone can be part of”*

US National Academies Educate to Innovate: Factors That Influence Innovation:  
Based on Input from Innovators and Stakeholders

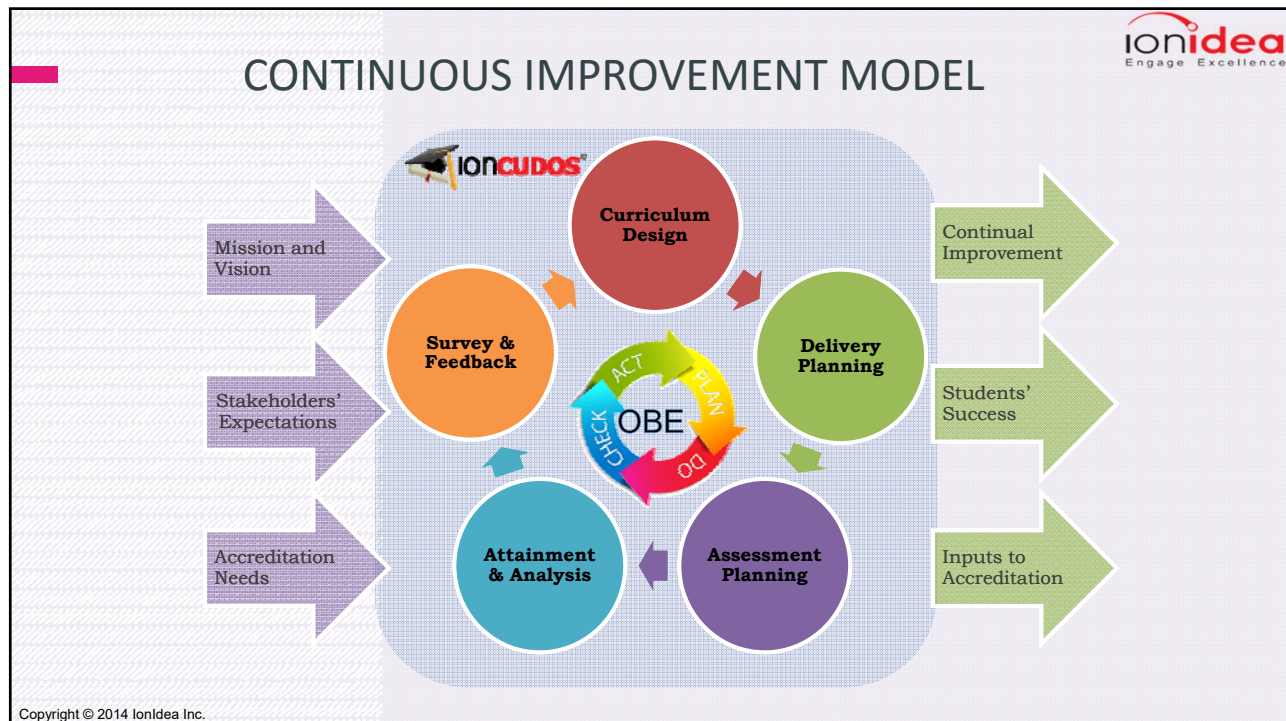






## Building capacity in instructional leadership

- Adopt a continuous quality improvement culture
- Establish a Center for Engineering Education Excellence
- IGIP International Engineering Educator Certification
- Re-write R<sup>4</sup> (role, responsibilities, reward & recognition)
  - Require all new professors a minimum training in instructional leadership
  - Promote self-learning (journals, books, conferences, networking)
  - Recognize good teaching (teaching excellence award)
  - Publish your instructional innovations
- Network to learn, partner (IFEES, ASEE, GEDC, SPEED, SEFI...)





**InnovaHiEd announces the Program to obtain the IGIP INTERNATIONAL ENGINEERING EDUCATOR CERTIFICATION**  
*an internationally accredited pedagogical qualification*  
Provides fundamental knowledge of the theory, the didactics and the methodology, as well as the best practices of engineering education to become effective teachers and mentors.

**6 months**  
**Face to face & online**  
**For engineering, technology & related disciplines professors, grad students**  
**Offered by world experts**

[www.innovahied.com](http://www.innovahied.com)  
[innovahied@gmail.com](mailto:innovahied@gmail.com)

IFSES LASPAU IGIP InnovaHiEd

## IGIP International Engineering Educator Certification Program

- An internationally accredited pedagogical qualification
- Provides fundamental knowledge of the theory, the didactics and the methodology, as well as the best practices of engineering education to become effective teachers and mentors.
- Face-to-face and online components... “learning by doing”

Professors who complete this program are encouraged to use the title of **Ing.Paed.IGIP** in their business cards, to be recognized as a bona-fide International Engineering Educator, per IGIP global standards.

<http://www.igip.org/igip/ing-paed-igip>  
<http://innovahied.com/>







## Competency based, student centered curriculum



InnovaHiEd

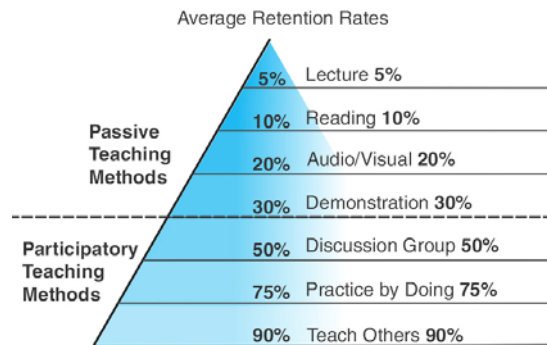




## Build capacity in Learning Methods

- Should address ALL learning styles
- Traditional lecture (active breaks, avoid death by power point!)
- Demos
- Hands on learning
- Peer learning
- MOOCs
- Industry visits
- PBL, PyBL
- Presentations
- Reports
- Teamwork
- .....

### The Pyramid Learning



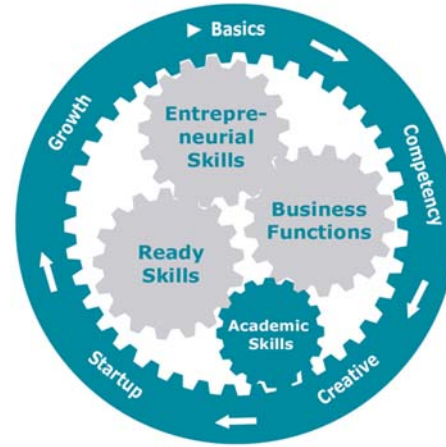
Adapted from National Training Laboratories. Bethel, Maine

Anything but just lecture!



## Innovation & entrepreneurship track

- **“Ready (basic)” skills**  
business foundations, communications & interpersonal skills, digital skills, economics, financial literacy
- **Business functions**  
day-to-day skills that are essential to the success of any business be it a home-based venture or a fast-growing corporation.
- **Entrepreneurial skills**  
entrepreneurial processes & entrepreneurial traits/behaviors



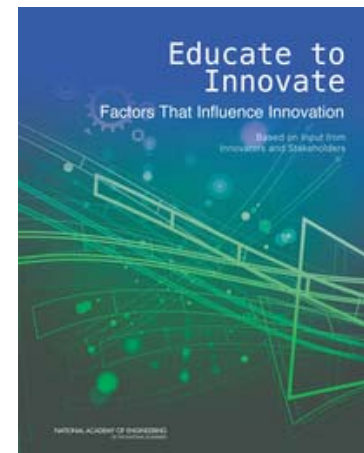
## innovation & entrepreneurial track

Consortium for Entrepreneurship Education  
www.entre-ed.org



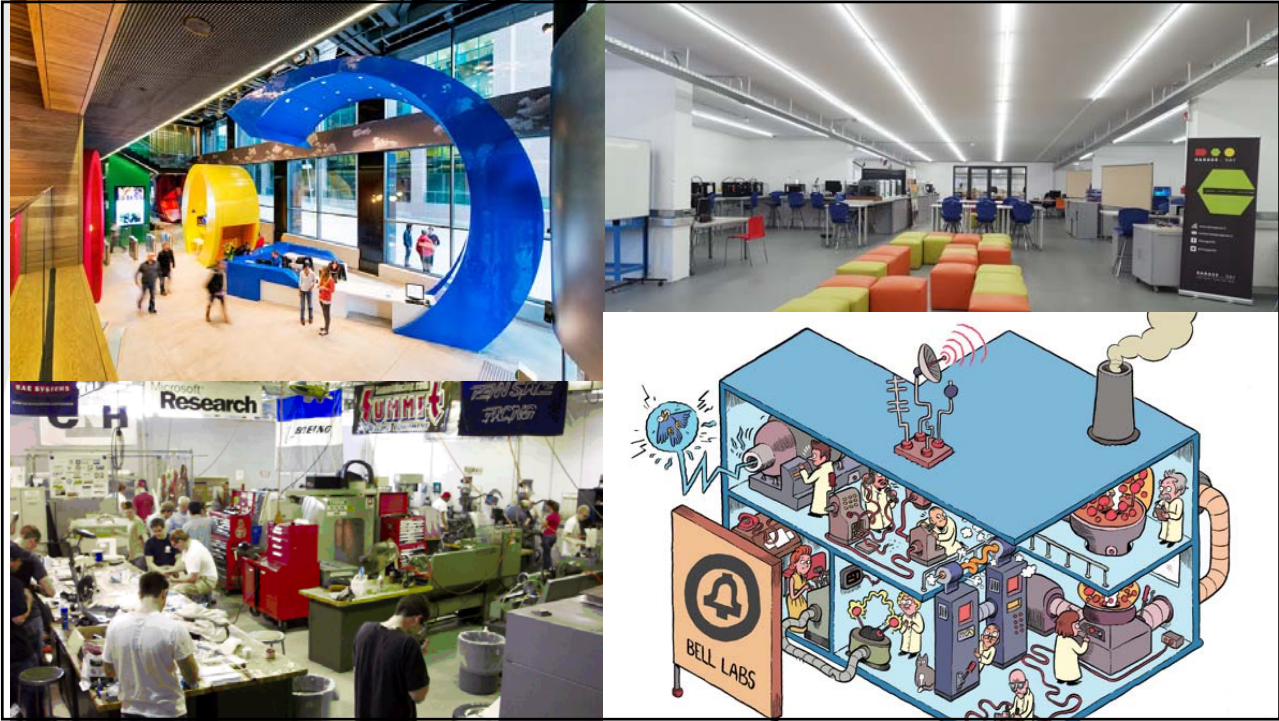
*“[Environments that] explicitly encourage innovation, have physical spaces for free/open/informal discussions, facilitate interdisciplinary collaboration, encourage following one’s passion, place a strong emphasis on the value of education, and provide freedom to tinker.”*

Educate to Innovate, US National Academies, 2015



**creative spaces for generating & exploring ideas**







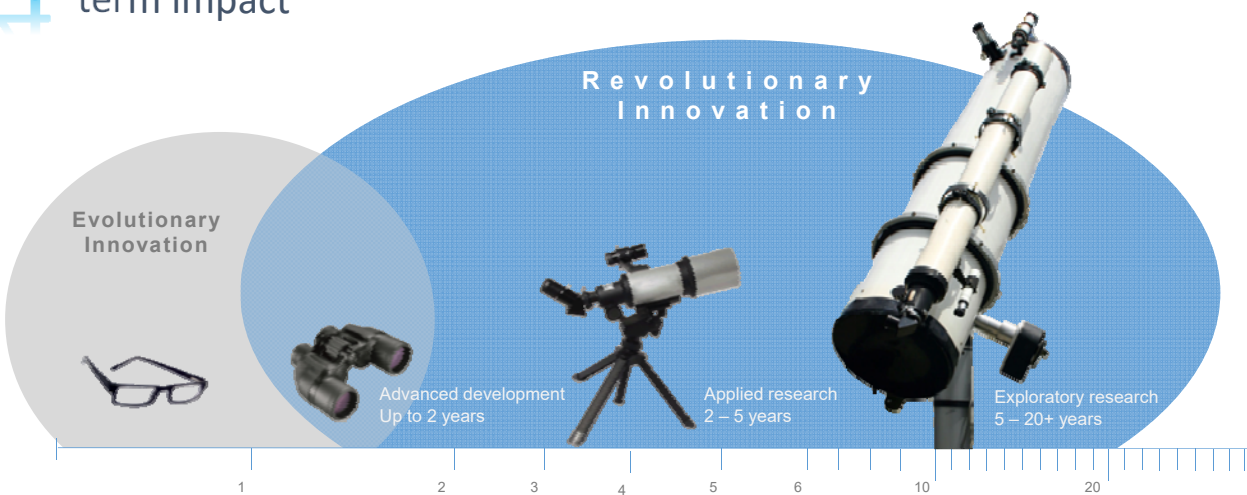
“Industry experience adds value for everybody. I think it’s a wonderful experience to get into an industrial lab and have an internship experience or in some way get broadened. Even if the person’s whole ambition is to be academic forever, it doesn’t hurt, and it’s not a very big time investment in terms of their overall time in college. I see tremendous learning from interns that we get here [at Corning] every summer.”

– David Morse

Educate to Innovate, US National Academies, 2015



## 4 Develop an R&D Portfolio with projects of short, medium & long term impact



**R&D thrusts: what we are good at, where opportunities lie**

Adapted from HP Labs



## 5 Provide incubator (shared) space with key support services

- Business plan writing and business basics
- Accounting & financial management services
- Legal assistance (IP, incorporation, import/export requirements)
- Access to capital
- Marketing assistance
- Access to broadband high-speed Internet
- Networking with other entrepreneurs, particularly other clients
- Assistance in developing presentation skills, business etiquette

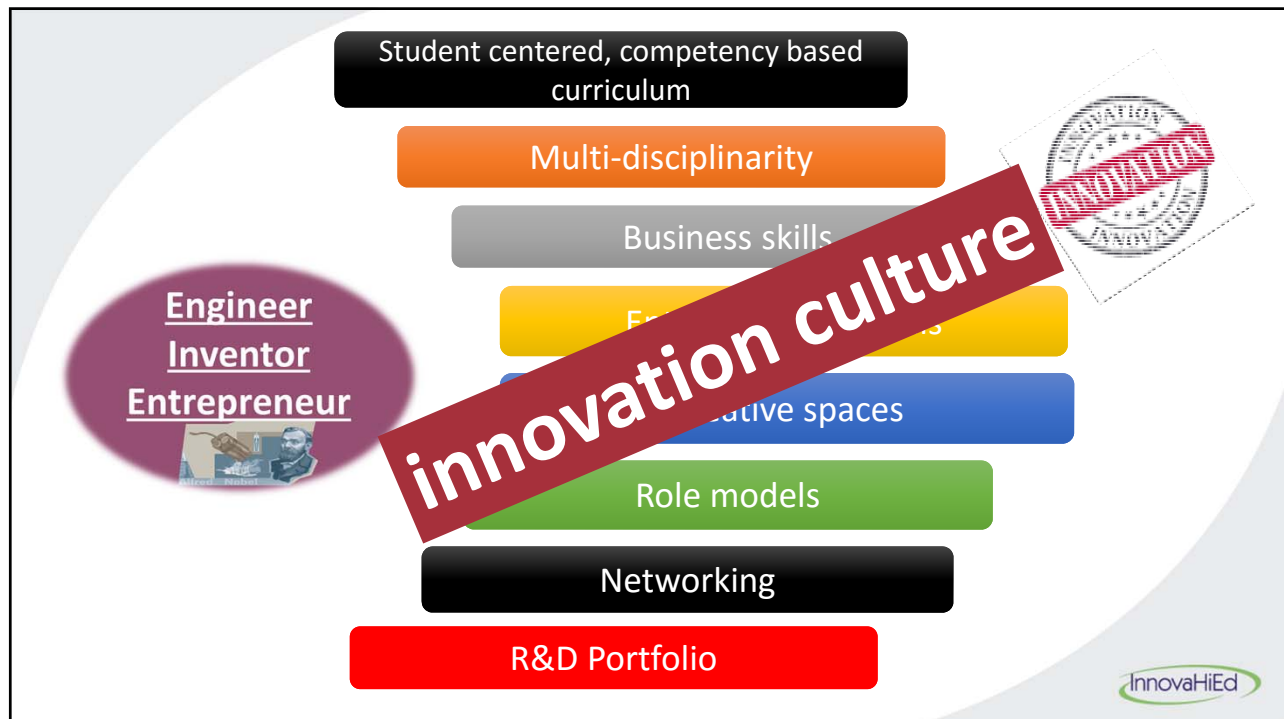


New learning platform for engineering education in Silicon Valley

[www.galvanizeu.com](http://www.galvanizeu.com)



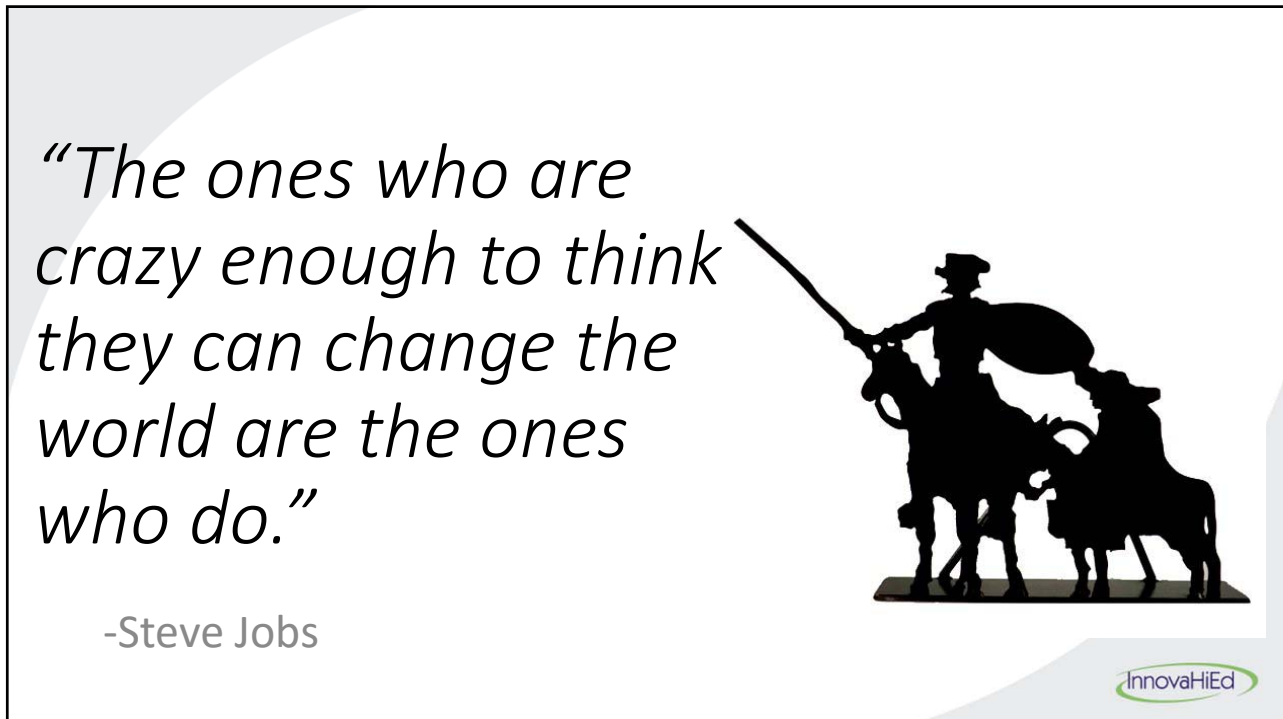
# how can we develop the next generation of innovators?





*“Start by doing what's necessary; then do what's possible; and suddenly you are doing the impossible.”*

St. Francis of Assisi



*“The ones who are crazy enough to think they can change the world are the ones who do.”*

-Steve Jobs

InnovaHiEd

¿Quiénes en esta audiencia se  
atreven a ser los próximos locos  
(digo, innovadores)?



**TO ENGINEER IS HUMAN**

ENGINEERING FROM 1964-2014





¡Gracias!  
Thank you!

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[www.luenymorell.com](http://www.luenymorell.com) (blog)  
[www.innovahied.com](http://www.innovahied.com)

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