Ingeniería 2014
Latinoamérica y Caribe
Congreso - Exposición

Construyendo un Futuro
Regional Sostenible

4 al 6 de Noviembre de 2014 - Centro Costa Salguero - Buenos Aires - Argentina

Developing and Assessing Engineering Competencies

Lueny Morell
Lueny.morell@gmail.com
Miércoles 5 noviembre 2015
11:30

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Desarrolland y Evaluando Competencias de la Ingeniería

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agenda

- What are competencies and why are they so important?
- How can competencies be developed?
- How can competencies be assessed?
- Final thoughts
- Q/A

Competencies = $\sum$ knowledge, skills, attitudes/values

Why are competencies important?

Today's world

- VOLATILE
- UNREST
- COMPLEX
- AMBIGUOUS

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

10.9 BILLION

The world's expected
population in 2100
(up from current 7.2 billion)

Time, October 6 2014

Urban economic shifts

2007 – 8

2025 – 20/50

Urban economic clout moves east.

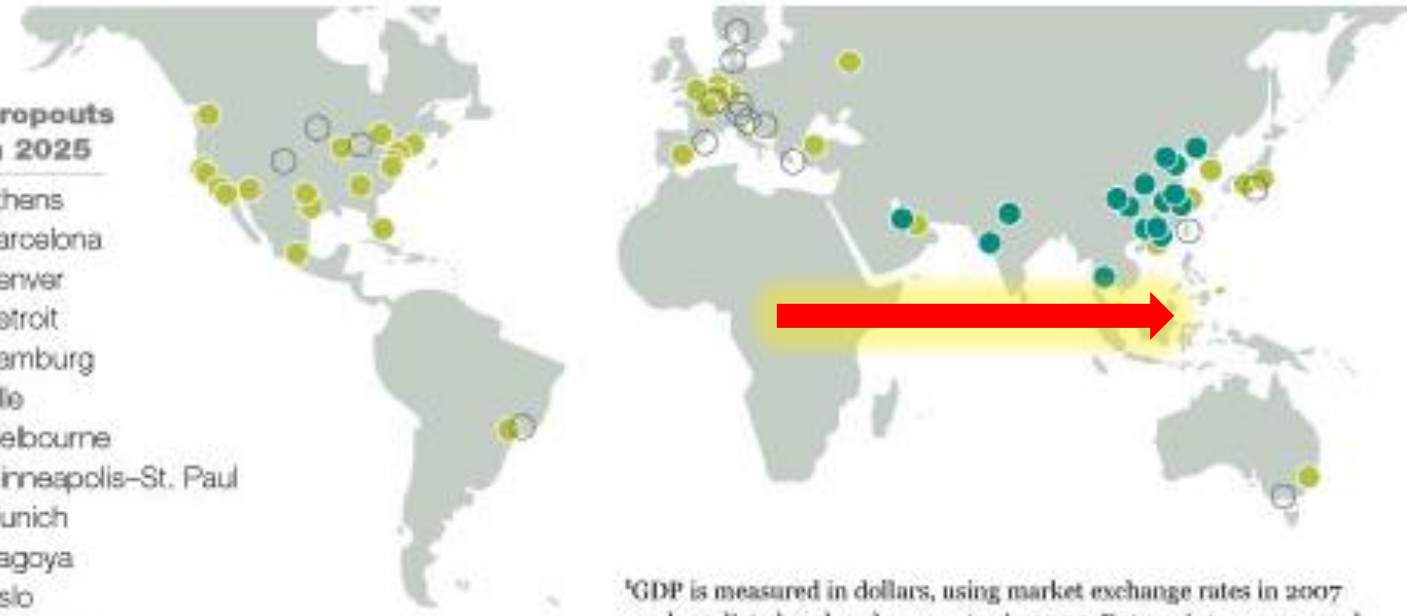
World's top 50 cities, ranked by GDP[1]

○ Dropout—included in 2007 but not in 2025

● Top 50 city in both 2007 and 2025

● Newcomer—absent in 2007 but included in 2025

Newcomers in 2025	Dropouts in 2025
Bangkok	Athens
Beijing	Barcelona
Chengdu	Denver
Chongqing	Detroit
Delhi	Hamburg
Doha	Lille
Foshan	Melbourne
Guangzhou	Minneapolis–St. Paul
Hangzhou	Munich
Mumbai	Nagoya
Nanjing	Oslo
Shenyang	Rhein–Main
Shenzhen	Rio de Janeiro
Tianjin	Stuttgart
Wuhan	Taipei
Xi'an	Vienna

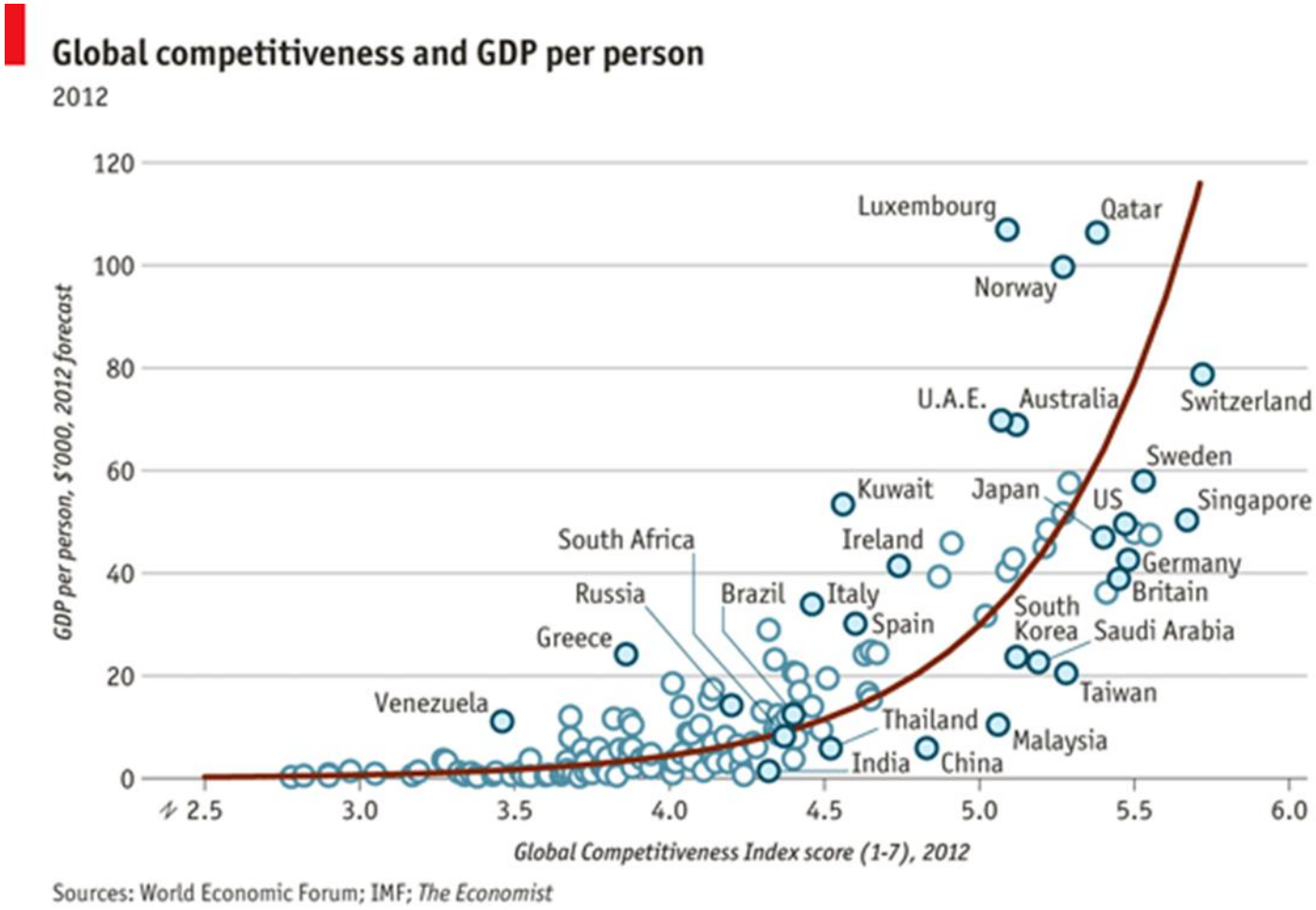


[1]GDP is measured in dollars, using market exchange rates in 2007 and predicted real exchange rates in 2025. Data points on map and in lists refer to metropolitan areas rather than specific city jurisdictions, aggregating neighboring cities when appropriate (eg, Rhein-Ruhr in Germany; Los Angeles, Long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

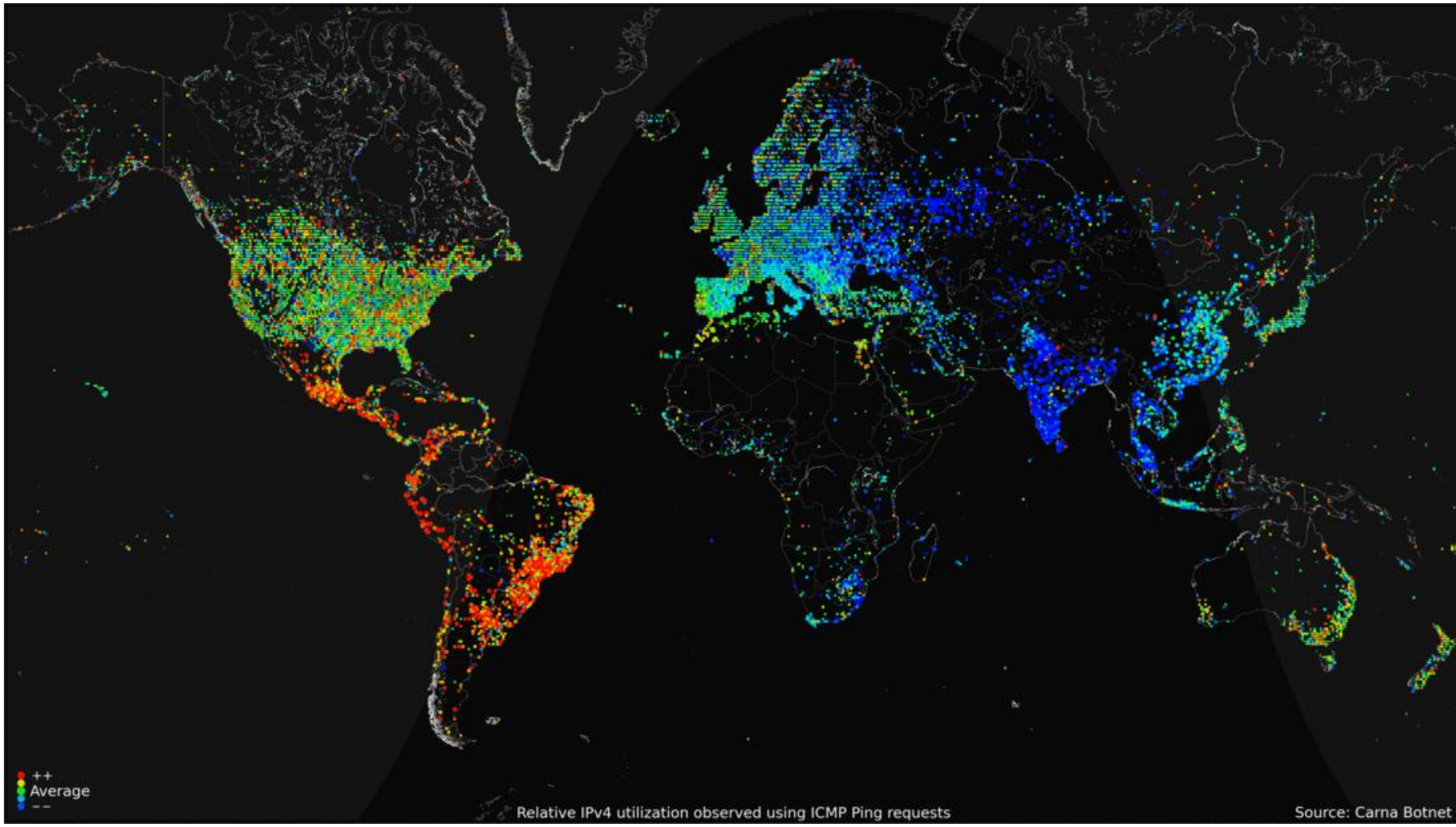
Source: McKinsey Global Institute

McKinsey Quarterly, September 2011 Newsletter

Global competitiveness & GDP (2012)

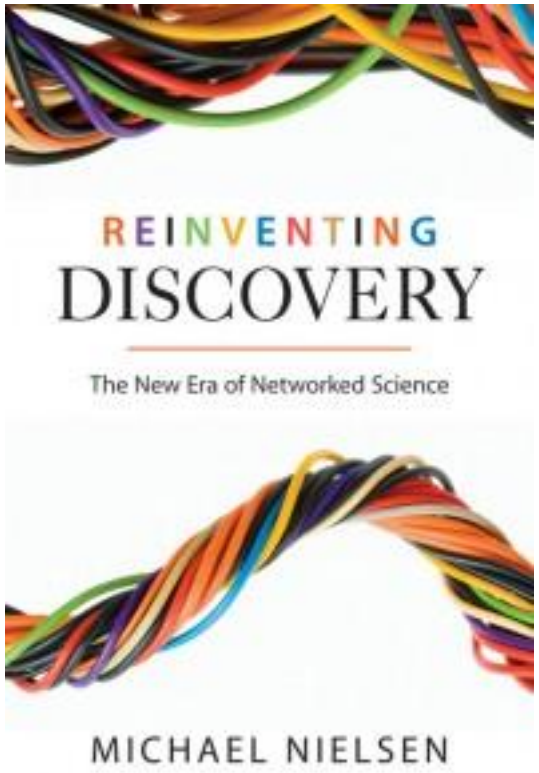


Enhanced communications



http://email.about.com/od/emailtrivia/f/emails_per_day.htm
http://motherboard.vice.com/blog/this-is-most-detailed-picture-internet-ever

R&D collaboration & global distribution intensifying

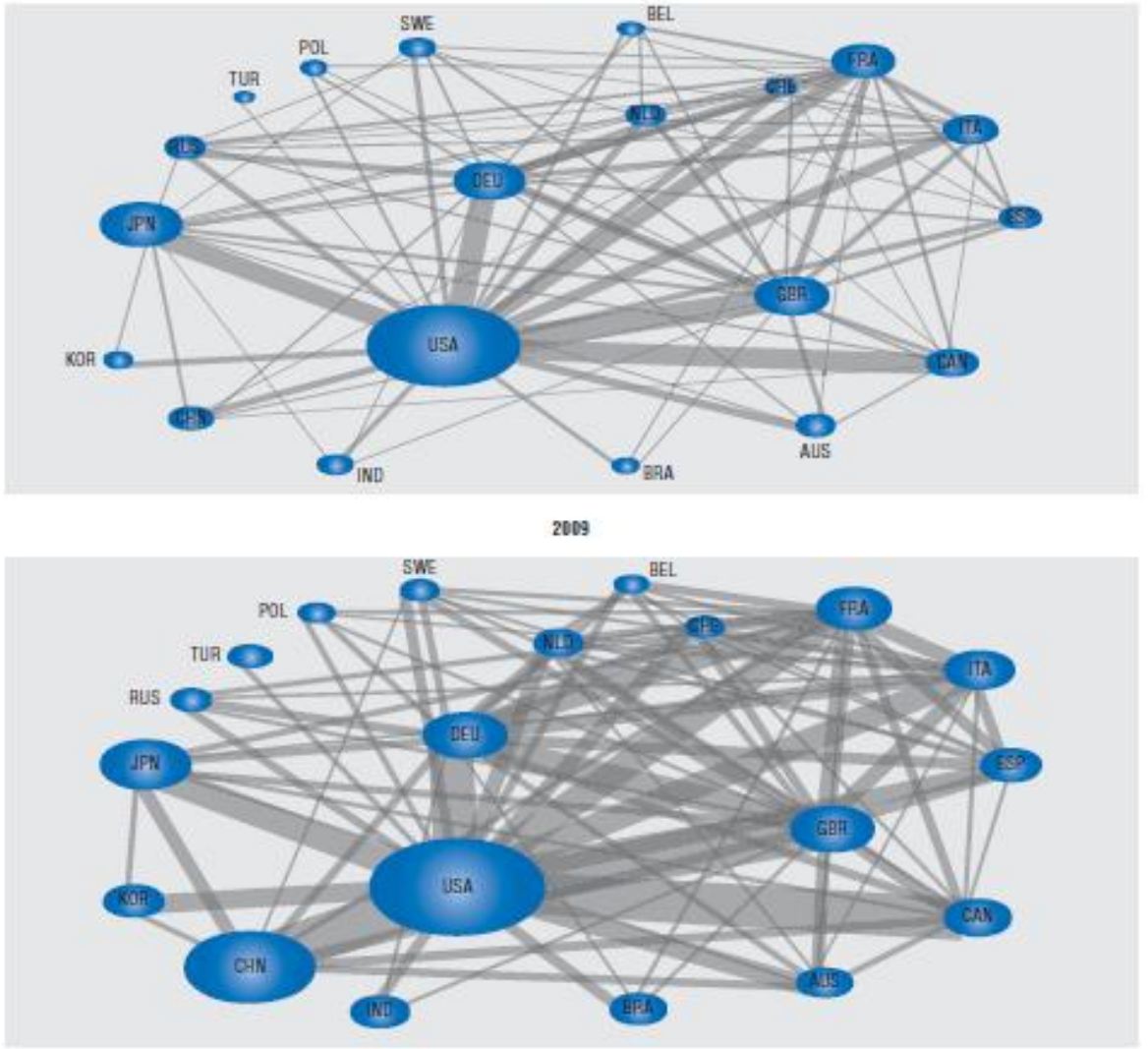


Intensifying collaboration in research

New players are emerging in the research landscape (the size of the bubble reflects the number of scientific publications) and collaboration is intensifying (the thickness of the link reflects the intensity of collaboration, i.e. co-authorships).

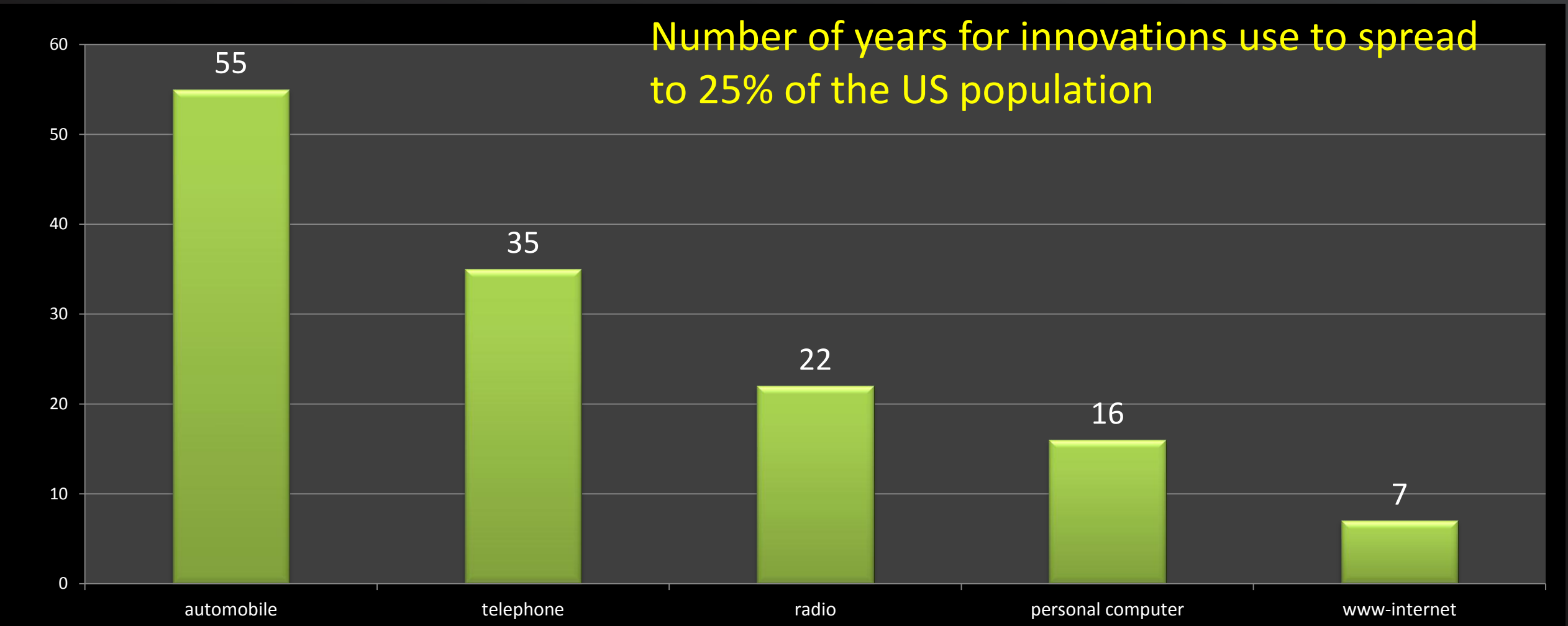
Scientific articles and co-authorship, 1998 and 2009

Numbers based on whole counts



Source: OECD, calculations based on Scopus Custom Data, Elsevier, December 2010.

Innovation is spreading at an ever-increasing rate



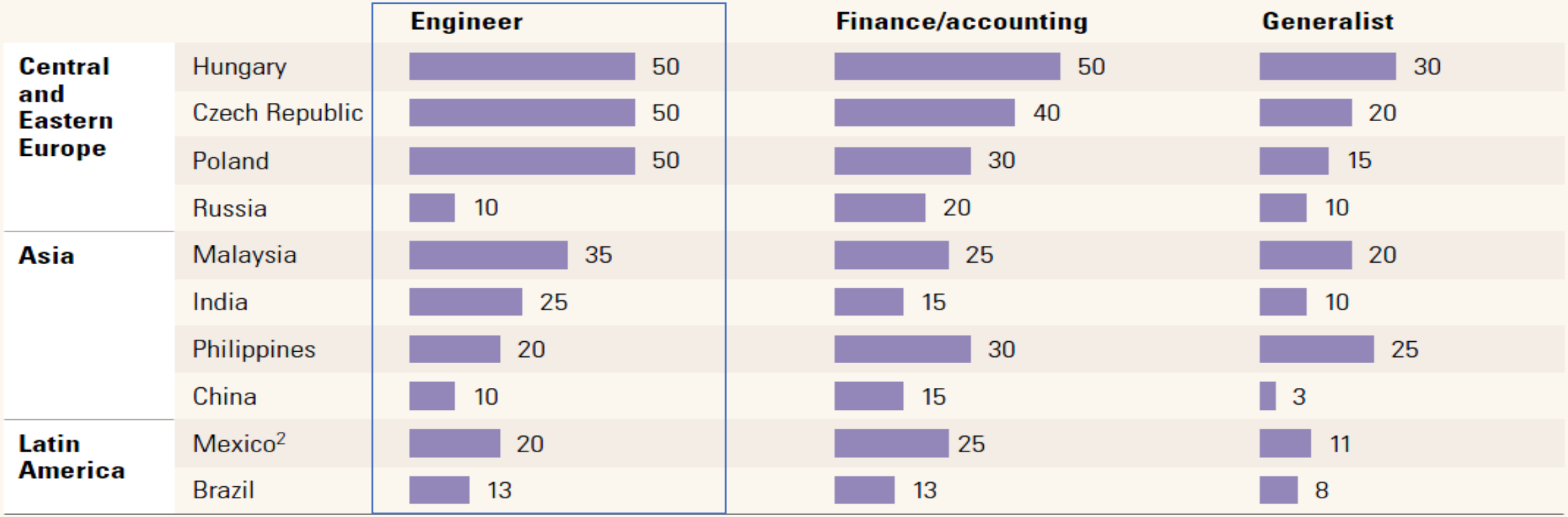
Source: Innovate America, a 2004 report from the Council on Competitiveness


“In the spirit of honoring traditions, universities hang on to past practices imperiling their future.”
Clayton
Christensen
Harvard University

The talent challenge

% of candidates considered suitable for hire[1]

Of 100 graduates with the correct degree, how many could you employ if you had demand for all?



[1] Suitability rates empirically based on 83 interviews with human-resources (HR) professionals working in countries shown.
[2] Mexico is the only country where interview results were adjusted—to 20% (from 42%) for engineers and to 25% (from 35%) for finance/accounting employees—since interview base was thinner and risk of misunderstandings high.

Source: Interviews with HR managers, HR agencies, and heads of global-resourcing centers; McKinsey Global Institute analysis

Source: McKinsey Quarterly, Making talent a strategic priority, January 2008

Latin America Numbers

- 57% of students in the social sciences, 16% in engineering
  - 3 psychology students for each engineering student
- Together with Africa, LA is the region with less investment in R&D
  - 2% of the world's investment (Brazil, Mexico, Argentina and Chile)
  - Asia/Pacific region amounts to 28%; Europe, 30%, US, 39%
  - All of LA & Caribbean countries invest LESS than South Korea
  - South Korea: 7500 patents; Brazil: 100
- Why these low numbers?
  - R&D is mainly conducted in universities, disconnected with the market needs
  - Obsession with past history
  - Politics
  - Long vacations
  - Arrogance?
  - …

Source: Andrés Oppenheimer, Basta de Historias, 2010

Latin America Numbers

– 57% of students in the social sciences, 16% in engineering
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"Las universidades (en la región) se han convertido en vacas sagradas… cuando deben ser pilar fundamental para preparar a los países para tener los conocimientos y habilidades para competir en un mercado mundial"

Andrés Oppenheimer, 2010

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- …

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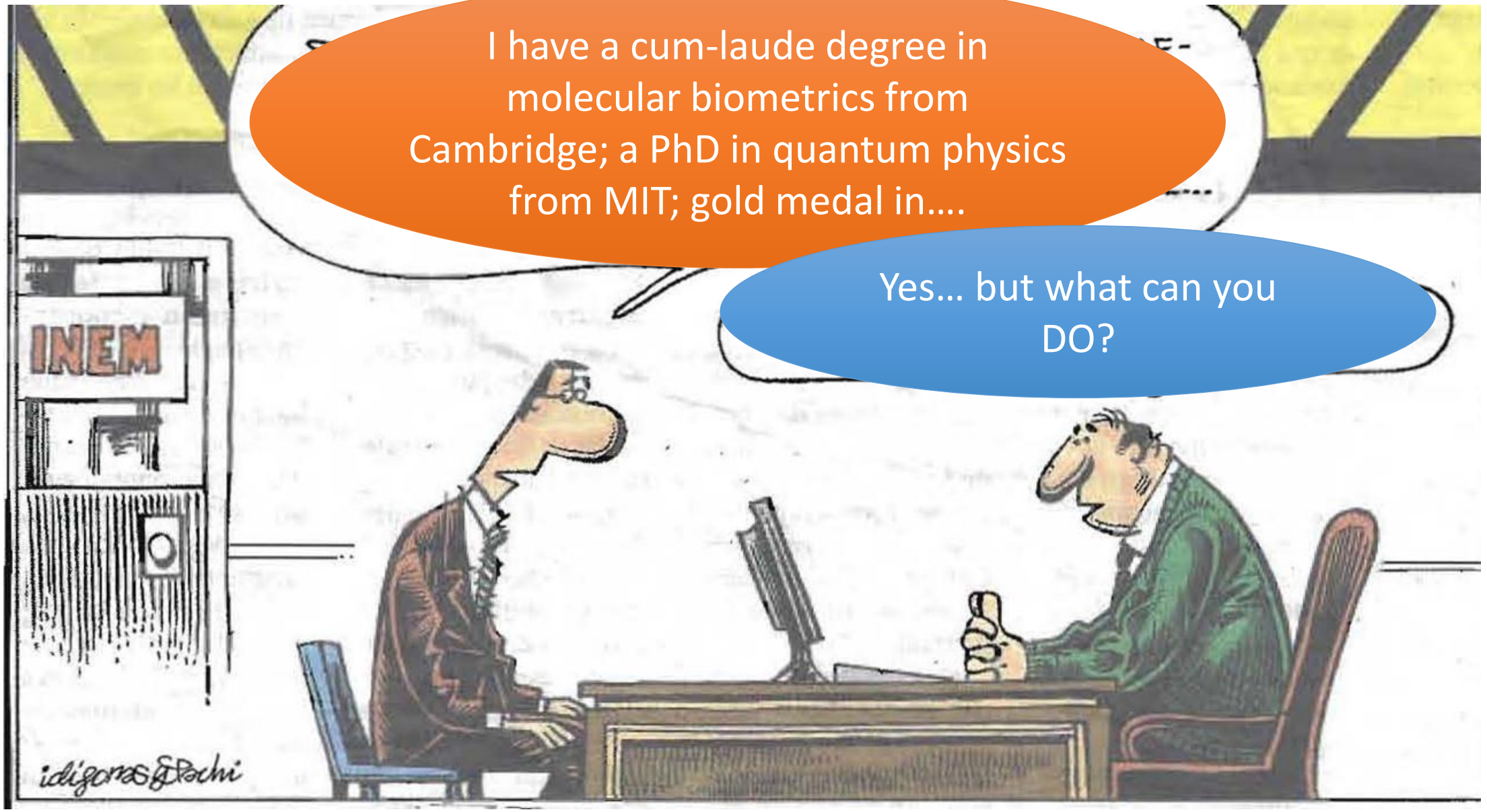
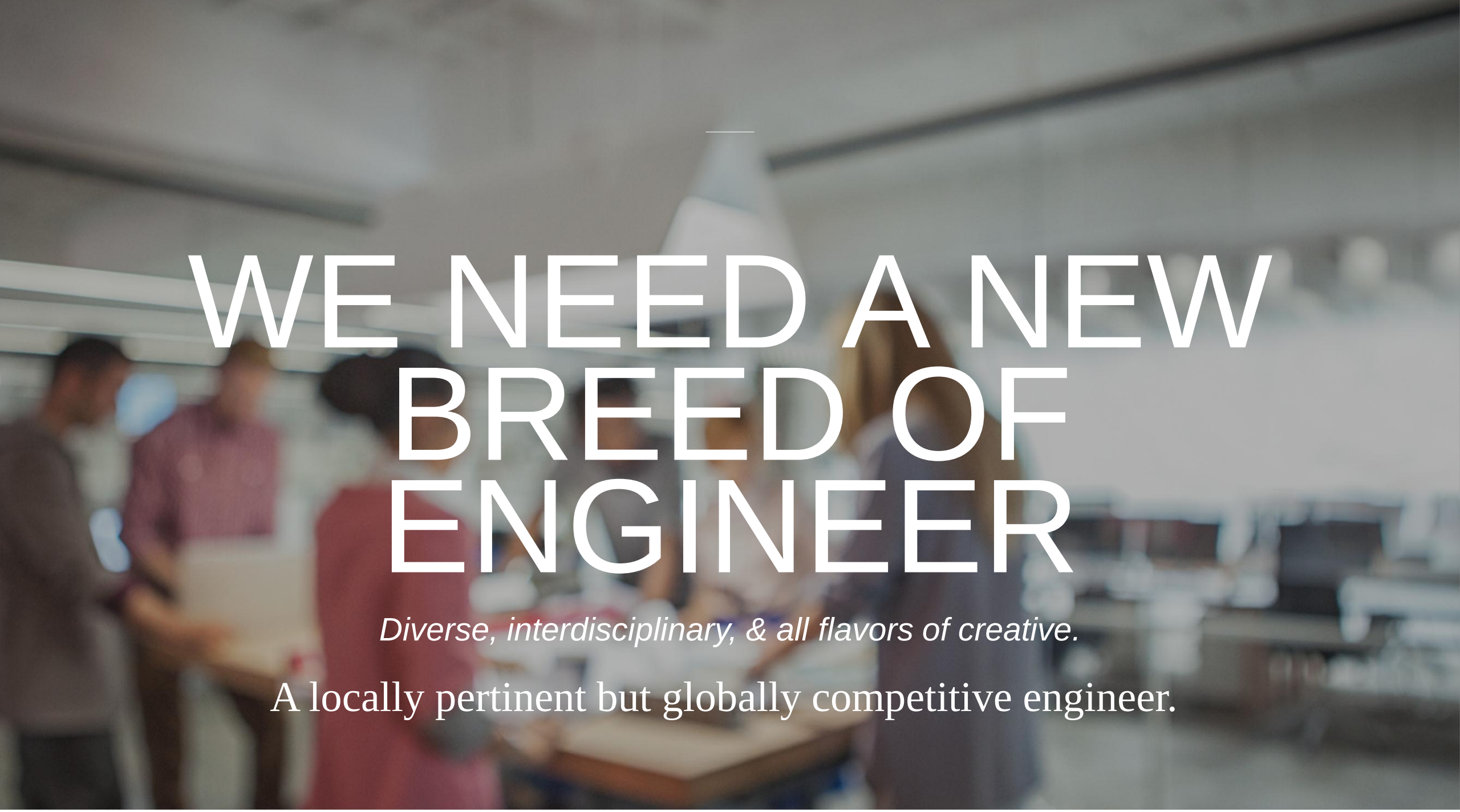

I have a cum-laude degree in molecular biometrics from Cambridge; a PhD in quantum physics from MIT; gold medal in….
Yes… but what can you DO?
INEM



WE NEED A NEW BREED OF ENGINEER

Diverse, interdisciplinary, & all flavors of creative.

A locally pertinent but globally competitive engineer.


BREADTH
DEPTH
AT COMPETENCIE

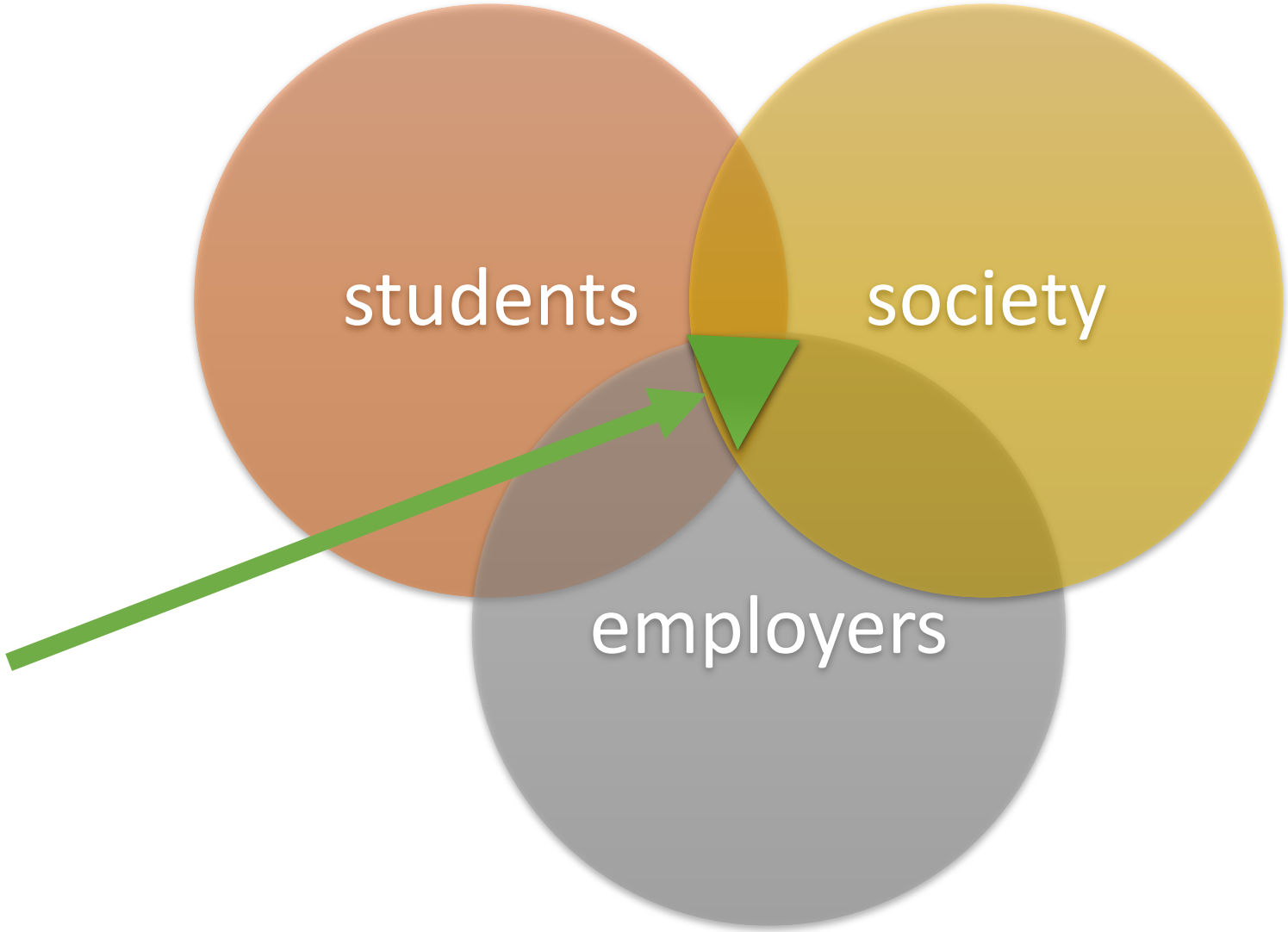

IN ENGINEERING - SKILLS/ATTITUDES & VALUES ARE CRITICAL
IT'S NOT WHAT YOU KNOW… BUT WHAT YOU CAN DO WITH WHAT YOU KNOW!

WHAT ARE YOUR COUNTRY'S ECONOMIC CLUSTERS?

WHAT ARE THEIR CURRENT & FUTURE NEEDS?

WHAT KNOWLEDGE?

Traditional plus…



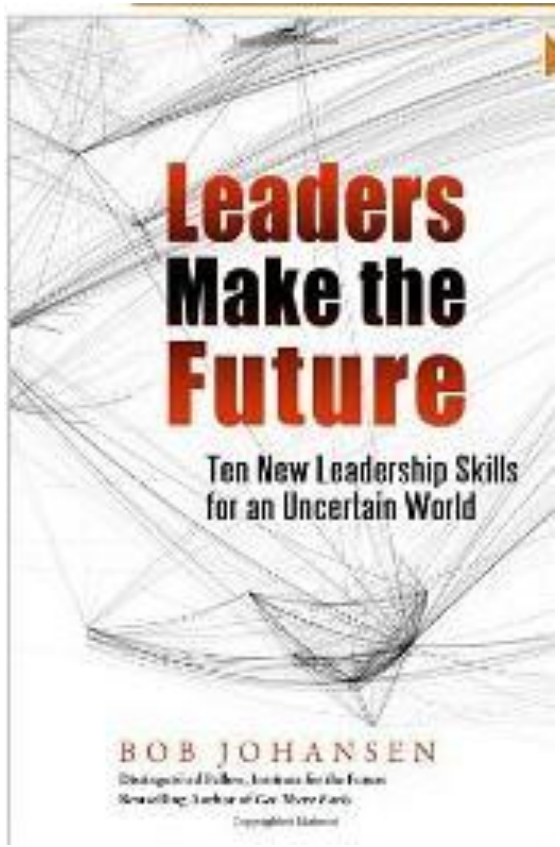

BIG DATA

SKILLS, ATTITUDES & VA

Employers' opinions on engineering competencies

Skill/Quality	Weighted average rating*
Ability to work in a team structure	4.60
Ability to verbally communicate with persons inside and outside the organization	4.59
Ability to make decisions and solve problems	4.49
Ability to obtain and process information	4.46
Ability to plan, organize, and prioritize work	4.45
Ability to analyze quantitative data	4.23
Technical knowledge related to the job	4.23
Proficiency with computer software programs	4.04
Ability to create and/or edit written reports	3.65
Ability to sell or influence others	3.51

Professional skills of the 21st century technology leaders



- **Mobability** — 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
- **Emergensight** — 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
- .....

IQ vs EQ

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

Things I was not taught at my University

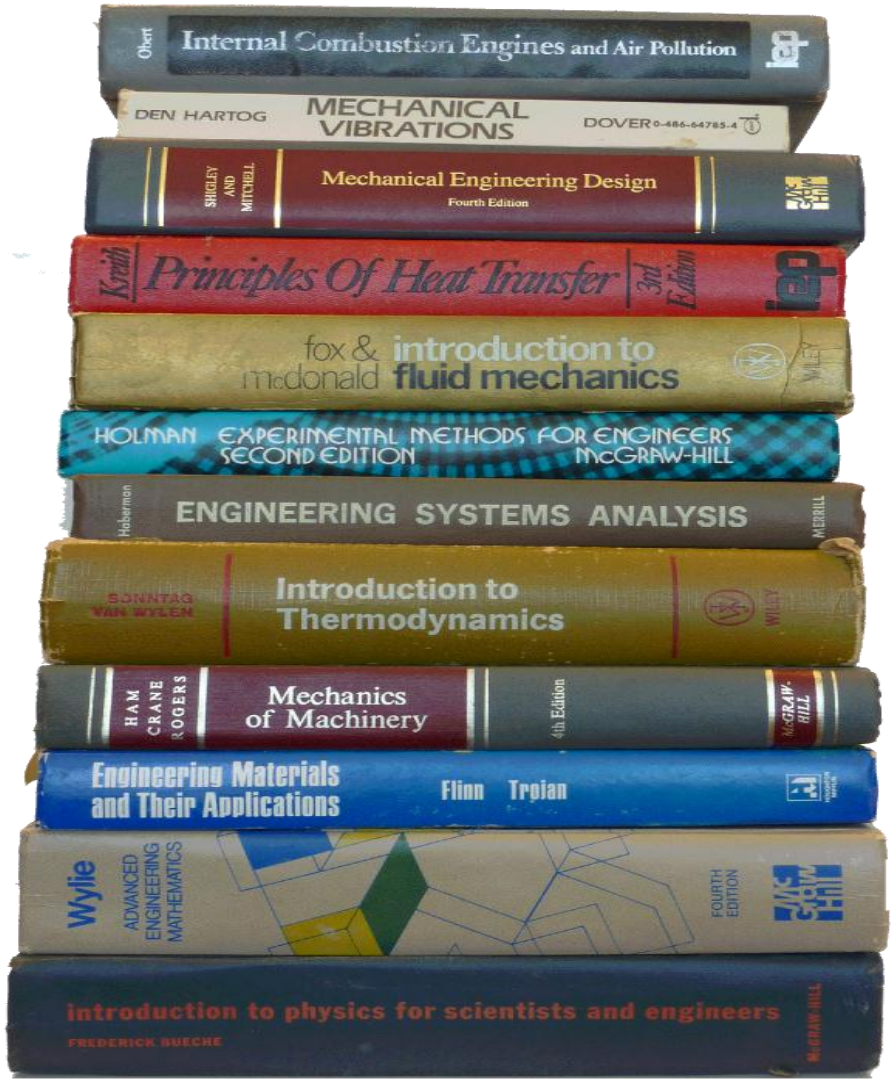
Communication (non-written)

Project management

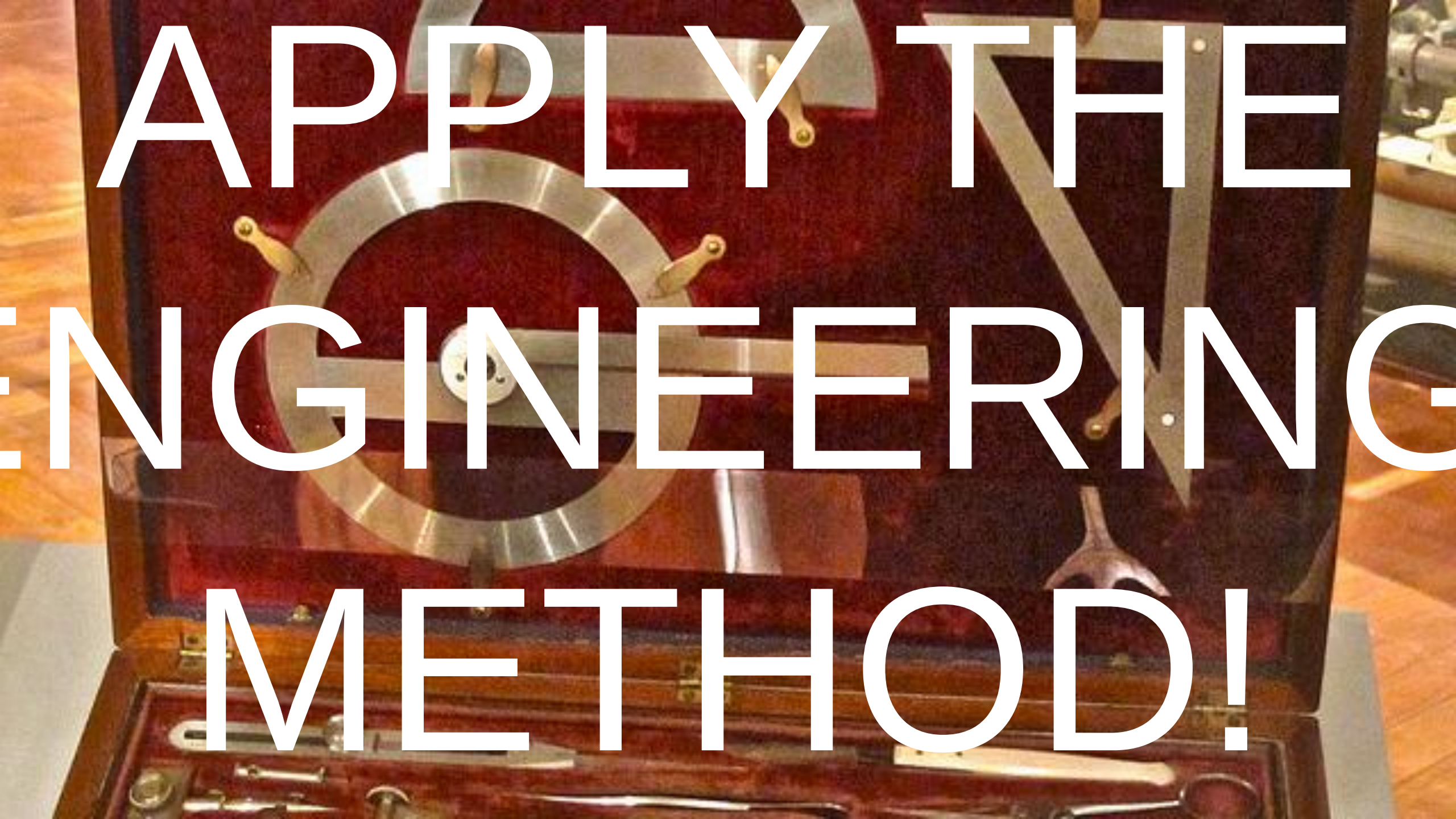
Business basics

Social conscience

…



HOW CAN COMPETENCIES BE DEVELOPED?


APPLY THE
ENGINEERING
METHOD!

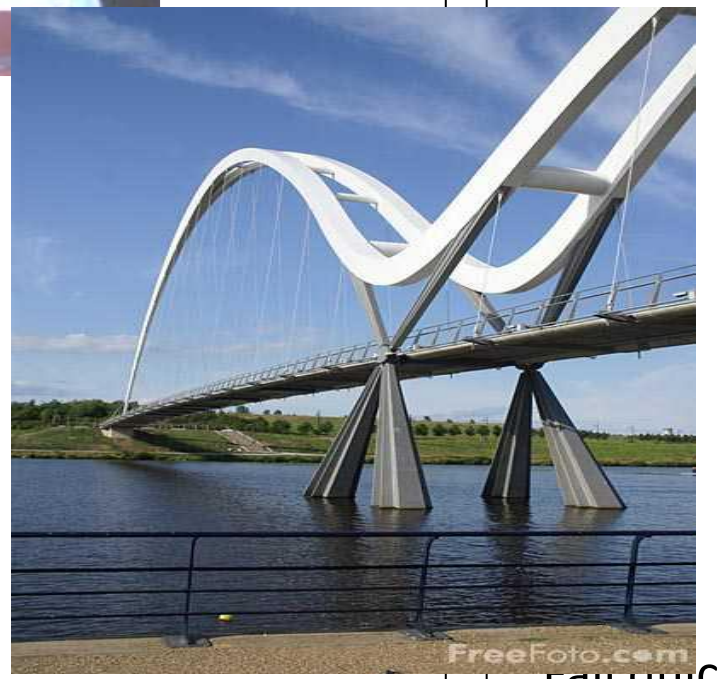
5 STEPS

1. DEFINE COMPETENCIES
2. PLAN THE LEARNING PROCESS
3. MEASURE & ANALYZE OUTCOMES
4. SHARE & DISCUSS

Learning Outcomes	Outcome 1 - Evaluate and use big data systems engineering to analyze, evaluate, and design technologies in an enterprise setting	Outcome 2 - Design solutions to big data challenges taking economic and societal constraints into account	Outcome 3 - Work in multi-disciplinary, multi-stakeholder, culturally diverse teams	Outcome 4 - Communicate effectively with multiple stakeholders	Outcome 5 - Leverage and influence professional networks	Outcome 6 - Apply security and ethical standards	Outcome 7 - Manage projects and time effectively	Outcome 8 - Respect and embrace diversity and cultures	Outcome 9 - Be flexible and adaptive
*Courses/Depth of Learning**									
CSBD 5001: Introduction to Big Data Technologies	3	-	1	1	1	1	-	1	1
CSBD 5050: Big Data Leadership and Entrepreneurism	3	1	3	3	3	3	3	3	3
CSBD 5002: Big Data Infrastructure	5	5	1	1	1	3	1	1	1
CSBD 5003: The Art and Science of Inquiry	5	5	1	1	1	3	1	1	1
CSBD 5004: Big Data Visualization and Analytics	5	5	1	1	1	3	1	1	1
CSBD 5020: Big Data Governance and Stewardship	5	5	1	1	1	5	1	1	1
CSBD 5008: Special Topics in Big Data	3 to 5	3 to 5	1	1	1	3	1	1	1
CSBD 5009: Big Data Focus Elective	3 to 5	3 to 5	1	1	1	3	1	1	1
CSBD 5010: Big Data Industry Practicum	5	5	1	1	1	3	1	1	1
CSBD 5051: Big Data Capstone Project	5	5	1	1	1	5	1	1	1

The Way We Teach

Research-trained faculty
One-answer problems
Lecture, “recipe” labs
Analytical sophistication
Individual work
Few presentations
One country, one culture
Few constraints
Risk discouraged
“Just-in-case” delivery



Engineering Practice

Real experience valued
Multiple good solutions
Learn by doing
Get job done at lowest cost
Teamwork
Many presentations
Many countries, many cultures
Business constraints
Fail quickly to succeed sooner
“Just-in-time” learning

Learning environments

“I do not teach anyone,
I only provide the
environment in which
they can learn ”

Albert Einstein


(H)INKE
SPACE

What we can learn from Google, IDEO and Pixar?

- IDEO: A transparent space where projects take the spotlight
- Google: Holistic environments and a playful culture
- Pixar: The art and science of spontaneity and story

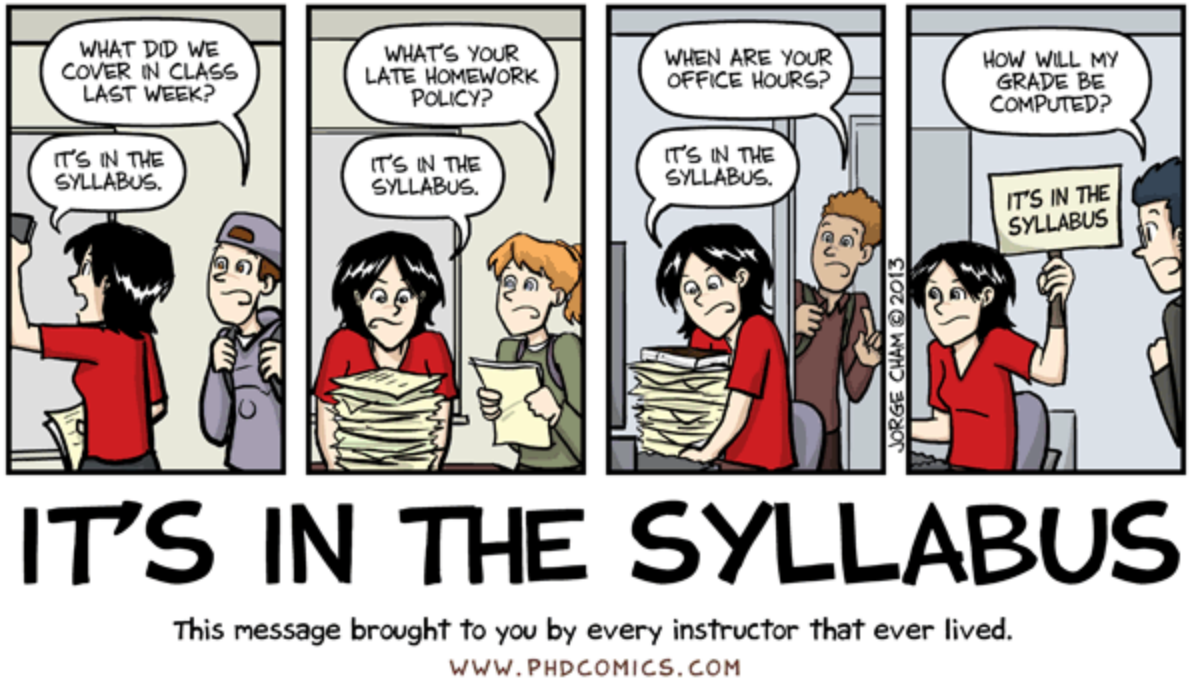
http://www.fastcodesign.com/1664735/what-schools-can-learn-from-google-ideo-and-pixar

From this

To this

Go beyond the lecture!

- Skills development
  - Writing, presenting
  - Ethics across the curriculum
  - Student teams
- Practical experiences
  - Industry internships
  - Industry projects
  - Real life examples
- Industry Advisory Boards
- Active learning
  - Project/problem based learning
  - Cooperative/collaborative learning



HOW CAN COMPETENCIES BE ASSESSED?

Traditional methods (exams, quizzes) + tools for assessing “soft skills” (teamwork, ethics)

Assessment tool	To be completed by	Timeline	Responsible
Pre-Survey (all learning outcomes + reflection)	Students	First day of class	Provost office
Exit-Survey (all learning outcomes + faculty evaluation + reflection)	Students, Faculty, Alumni, Employers	Last day of class, every three years (for alumni & employers)	Provost office
Hmwk, tests, projects	Students	All courses	Faculty
Teamwork assessment	Students, Peers	Once per year - tbd	Faculty
Oral presentation assessment	Students, Peers	All courses	Faculty
Written report assessment	Students	All courses	Faculty
Networking Focus Group	Selected group of students	Once per year - tbd	Faculty
Ethics assessment	Students, peers	Once per year - tbd	Faculty
Project management assessment	Students, peers	Once per year - tbd	Faculty
Diversity Focus Group	Selected group of students; selected group of faculty	Once per year – tbd	Provost Office
Adaptability Focus Group	Selected group of students; Selected group of faculty	Once per year – tbd	Provost Office

NEU-UNH Learning Outcomes Assessment

TEAMWORK

Palo Alto, California

draft

Date: _____

Your name: _____

Course: _____

Please list your group members and rate each one and yourself with respect to team p
on this scale:

1 - Poor 3 - Average 5 – Excellent

name of team member	participation
1.	
2.	
3.	
4.	
5.	

Define the group dynamics in your team:

Team members are willing to listen to and respect each other's ideas and input.

____Never ____Seldom ____Sometimes ____ Often ____Always

Team members are helpful towards each other.

____Never ____Seldom ____Sometimes ____ Often ____Always

Conflicts among team members are resolved effectively and constructively.

____Never ____Seldom ____Sometimes ____ Often ____Always

There is a dominant member in your group that exerts control over all other members

____Never ____Seldom ____Sometimes ____ Often ____Always

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than evaluation of learning outcomes for the sole purpose of continuous improvement.

NEU-UNH Learning Outcomes Assessment

ETHICS ACROSS THE CURRICULUM

Palo Alto, California

dra

Date: _____

Your name: _____

Course: _____

Purpose: To determine the frequency and types of exposure to ethical issues in the curriculum.

Directions: Below you will find a series of activities in ethics. Assess your exposure to each activit
following scale:

1 - Poor or no exposure

3 - Adequate

5 - Excellent

Activity	5	4	3	2	1
a. Read parts of an engineering code of ethics					
b. Participated in a curricular or extracurricular activity that has a major ethical component					
c. Attended a special lecture or conference (outside of regular classes) with a major ethical component.					
d. Spent time identifying and addressing the ethical issues in a major design experience.					
e. Took a course in ethics					
f. Discussed ethics issues with my team members, professors and industry mentors					
g. An instructor included an ethics issue in one of his or her classes.					
h. A guest lecturer came to one of my classes and discussed ethical issues and cases.					
i. Participated in an ethics competition such as the ethics bowl.					
j. Participated in drafting a student code of conduct for my student association, for practicum experiences or other situations. Explain.					

NEU-UNH Learning Outcomes Assessment

ORAL PRESENTATION

Palo Alto, California

Date: _____

Your name: _____

Course: _____

Instructions: Use the following scale to assess the presentation.

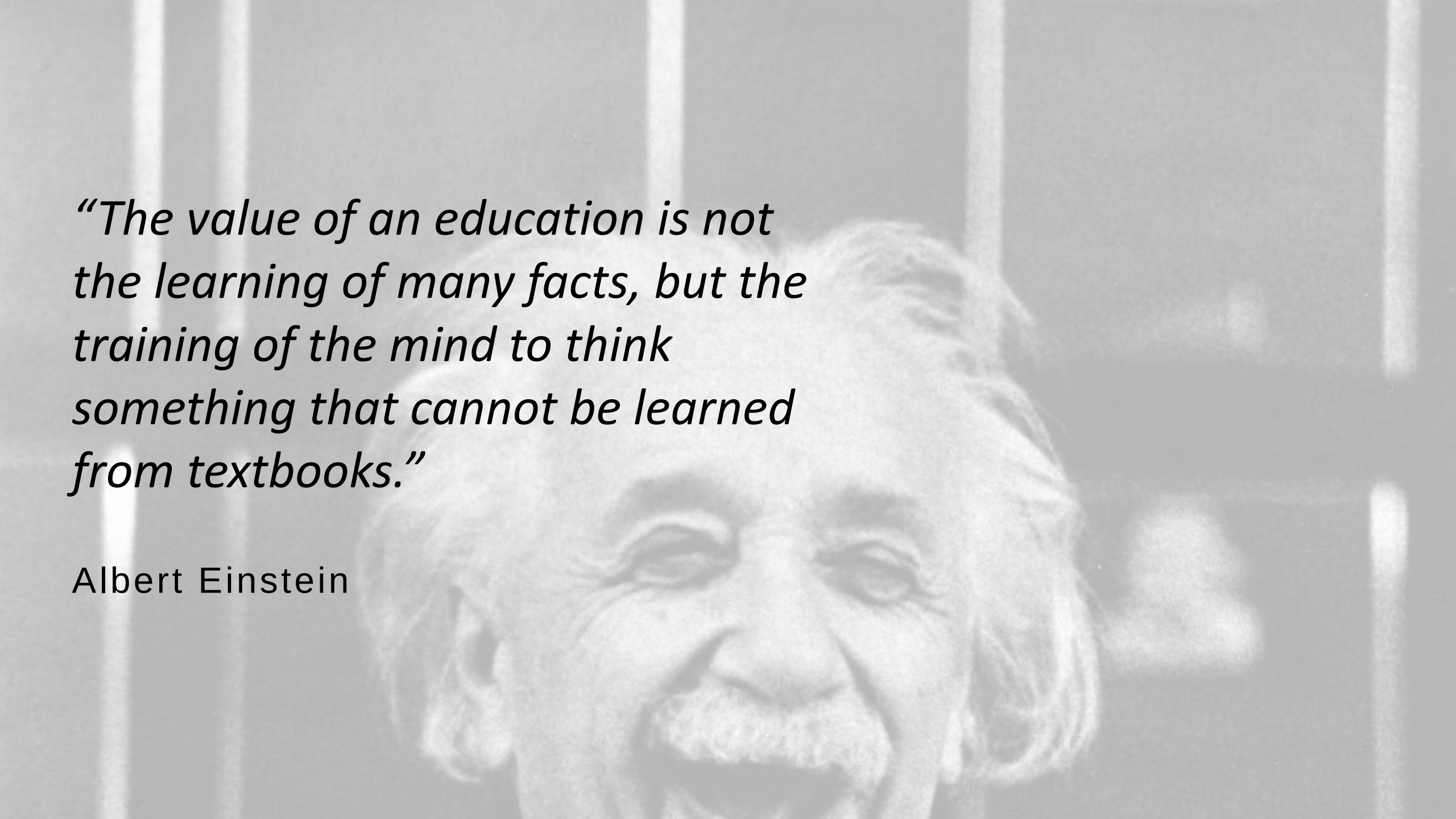
1 – Poor 3 – Average 5 – Excellent

Part 1 - PRESENTATION

CATEGORY	5	4
Organization		
Level		
Knowledge of material		
Time		
Delivery		
Quality of language		
Order/sequence		
Management of questions		
Ability to discuss project and methodology		
Personal appearance/manners		
TOTAL		

FINAL THOUGHTS


MISSION



“The value of an education is not the learning of many facts, but the training of the mind to think something that cannot be learned from textbooks.”

Albert Einstein

UNIVERSITIES' MISSION TRANSFORMATION

R/r e/E s

Driven by tradition, external funds, & individual work/recognition

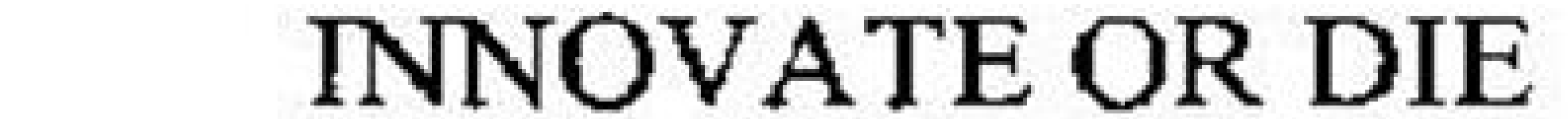
R E S

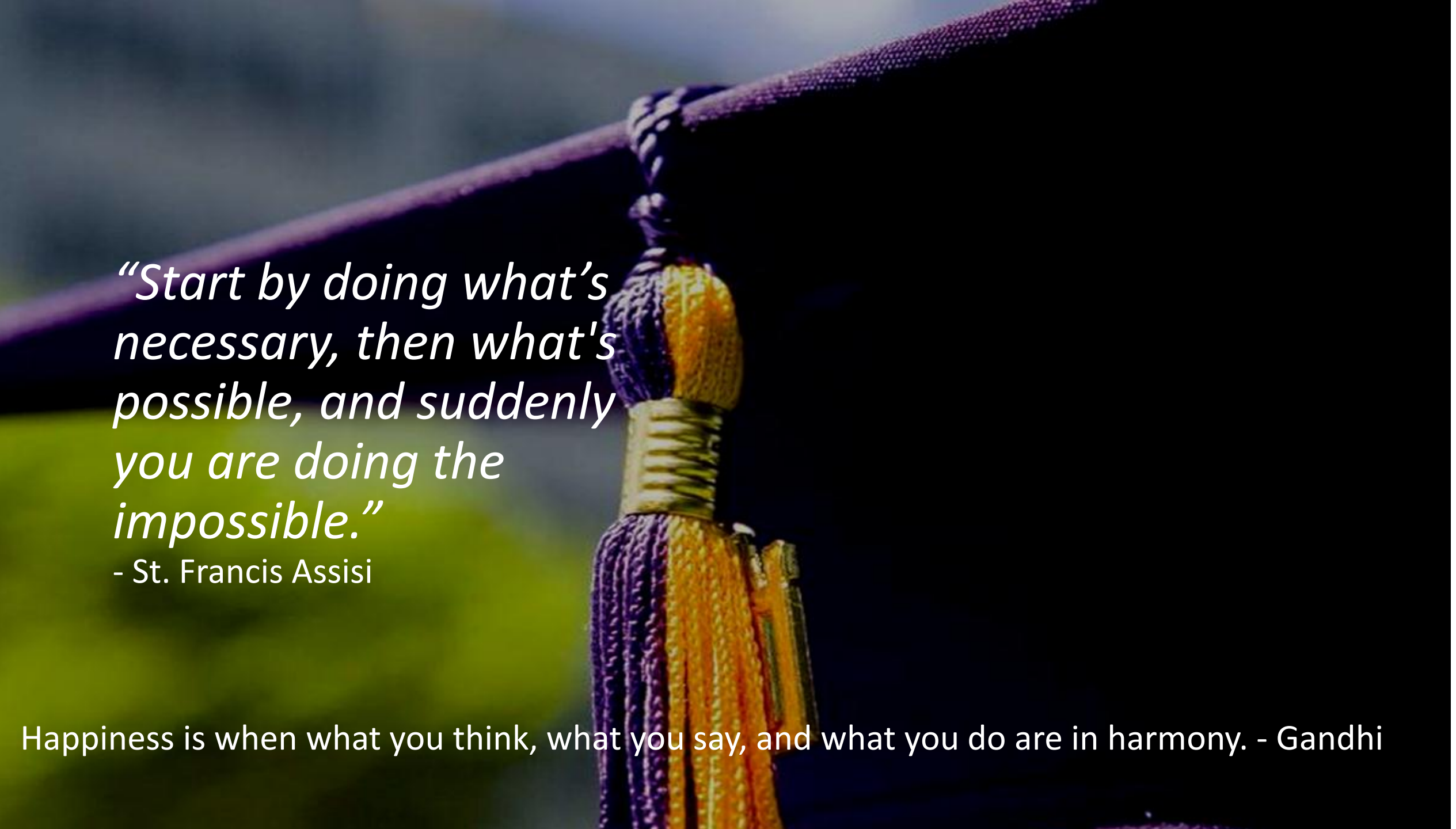
Driven by society's needs, common good & teamwork

Enablers: governments & funding agencies, rectors/deans, faculty,…


PROFESSOR REDER

DISRUPT OR BE





Happiness is when what you think, what you say, and what you do are in harmony. - Gandhi