

From the Ground Up: A Systems Approach to Rethinking Engineering Education

Richard K. Miller, Ph.D.

PRESIDENT, PROFESSOR, AND
FIRST EMPLOYEE



Olin College
of Engineering

Needham, Massachusetts, USA



ROYAL
ACADEMY OF
ENGINEERING

KEYNOTE ADDRESS

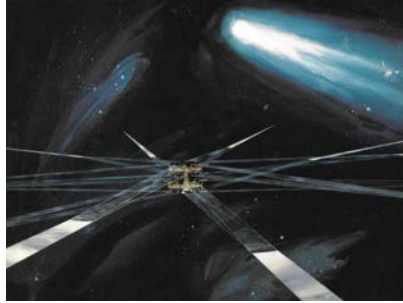
*Systems approach to creating the
global workforce of the future*

Royal Academy of Engineering

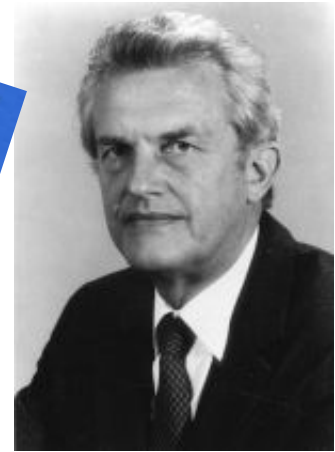
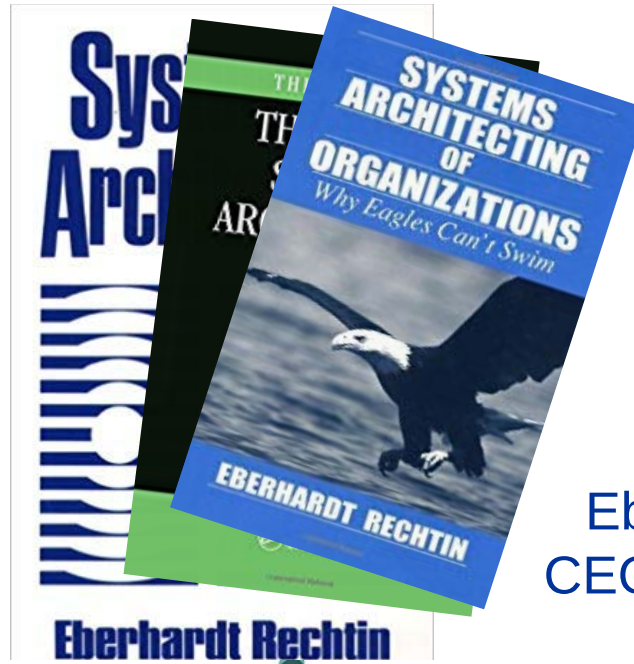
London, UK

September 24, 2018

Systems Architecting – *Personal Background*



Heliogyro Design
(Astro Research Corp c.1985)



Eberhardt Rechtin
CEO Aerospace Corp



Outline

- 1. Context: What Is Olin College?**
- 2. Lessons Learned**

Outline

- 1. Context: What Is Olin College?**
2. Lessons Learned

F.W. Olin Foundation

Timeline

- 1997 – Charter
- 1999 – First employee
- 2000 – Founding Faculty, begin campus construction
- 2001 – ***Olin Partner Year***
- 2002 – first courses taught
- 2006 – first commencement

“There is a lot of unhappiness about the way engineering is taught today...”

LAWRENCE W. MILAS, PRESIDENT, F.W. OLIN FOUNDATION,
FOUNDING CHAIRMAN, OLIN COLLEGE BOARD OF TRUSTEES



Franklin W. Olin



L.W. Milas



Joseph Bordogna
NSF
*Engineering Education
Coalitions Program*



John Prados
ABET
Criteria 2000

*“Olin College is intended to be different,
not for the mere sake of being different, but
in order to become an important and constant
contributor to the advancement of engineering
education in America and throughout the world...”*

FOUNDING PRECEPTS, OLIN COLLEGE

→ Olin College is intended to become an
education laboratory.

The Role of Olin College



No Tenure, No Academic Departments, \$100k Merit Scholarships, Everything has an Expiration Date



Olin College OF ENGINEERING Collaboratory

Since 2010, visited by more than 2,000 visitors from
830 universities and 55 countries



HARVARD
School of Engineering
and Applied Sciences



**KYOTO
UNIVERSITY**

Insper Instituto
de Ensino
e Pesquisa



THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

PURDUE
COLLEGE OF TECHNOLOGY



**PRINCETON
UNIVERSITY**



UNITED STATES MILITARY ACADEMY
WEST POINT



NUS
National University
of Singapore



**KHALIFA
UNIVERSITY**



NATIONAL ACADEMY
OF ENGINEERING



Compete.
Council on
Competitiveness

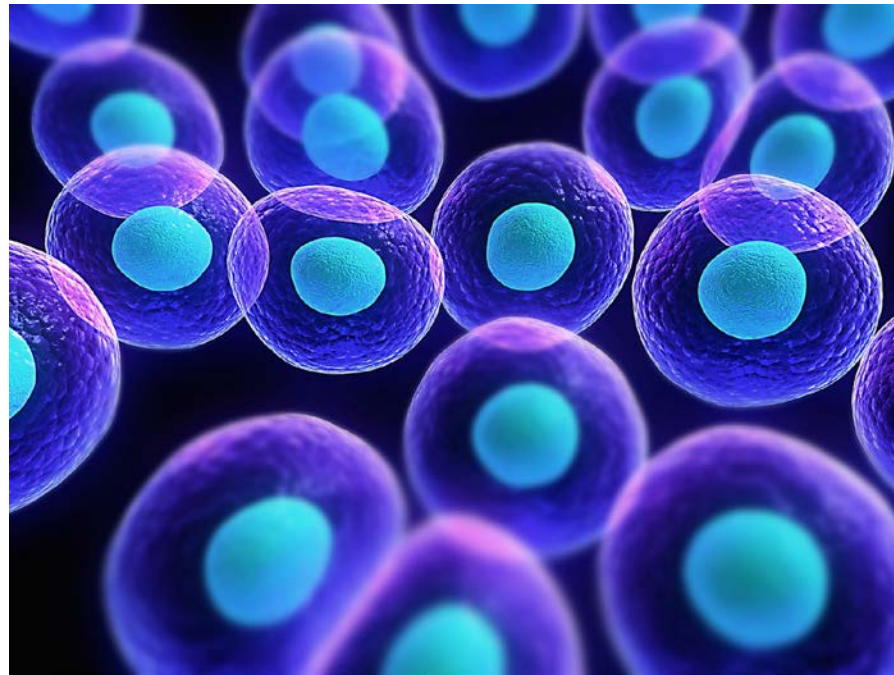


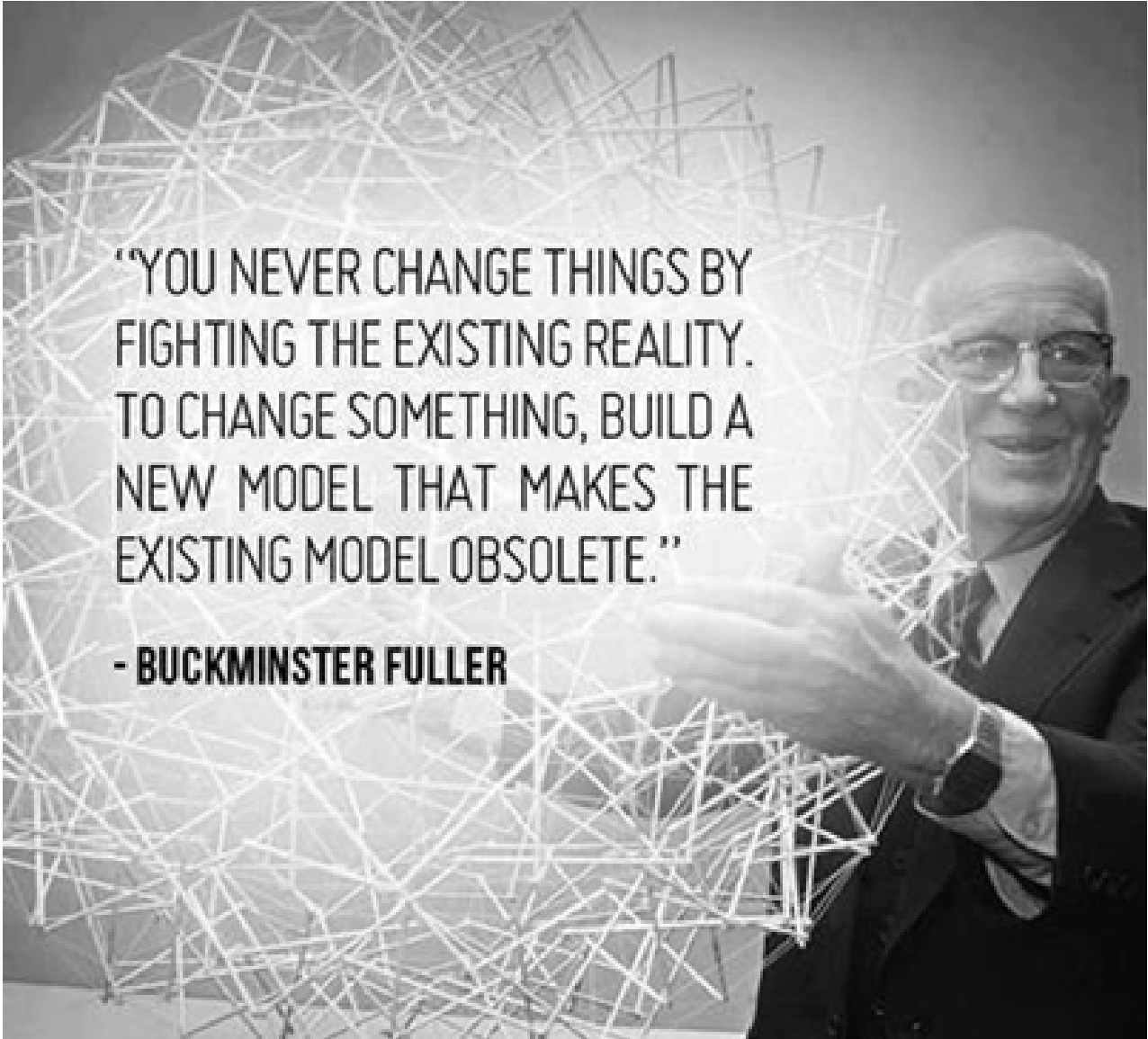
Features of the Olin Model Today

- 50% women
- Candidates Weekends
- 25-35 Design-Build Projects + Start/Run Business
- SCOPE – 2 semester Corporate Capstone (\$55k/team)
- EXPO – stand and deliver every semester
- Passionate Pursuits
- **Design Thinking + Intrinsic Motivation**
- Integrated Learning in Context

*“An engineer is a person who envisions
what has never been and does whatever it takes
to make it happen—to make a better world”*

Olin College produces
“Engineering Stem Cells!”



A black and white photograph of Buckminster Fuller. He is an older man with glasses, wearing a dark suit, white shirt, and tie. He is smiling and gesturing with his right hand towards a large, complex geodesic dome structure made of many thin rods. The dome is partially obscured by the text overlay. The background is a plain, light color.

“YOU NEVER CHANGE THINGS BY
FIGHTING THE EXISTING REALITY.
TO CHANGE SOMETHING, BUILD A
NEW MODEL THAT MAKES THE
EXISTING MODEL OBSOLETE.”

- BUCKMINSTER FULLER

Outline

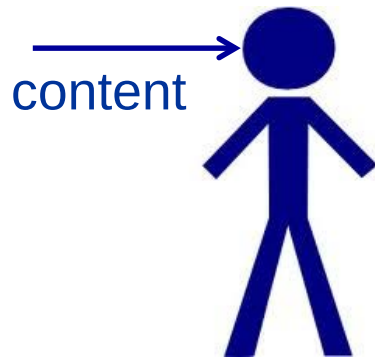
1. Context: What Is Olin College?
- 2. Lessons Learned**

The Future of Higher Education

Yeats: Education is not the filling of a pail, but the lighting of a fire!

TIME →

**KNOWLEDGE
ECONOMY**

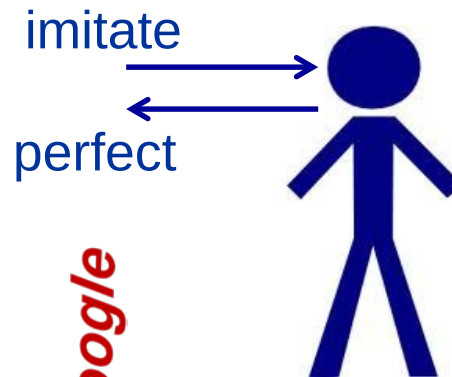


Sage on Stage

*Rows of seats
with Blackboard*

What you Know

**MAKER
ECONOMY**

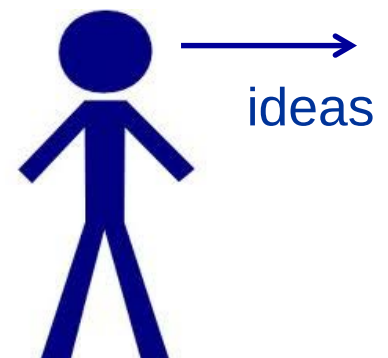


Guide on Side

*Small groups
with Maker Projects*

What you can Do

**INNOVATION
ECONOMY**



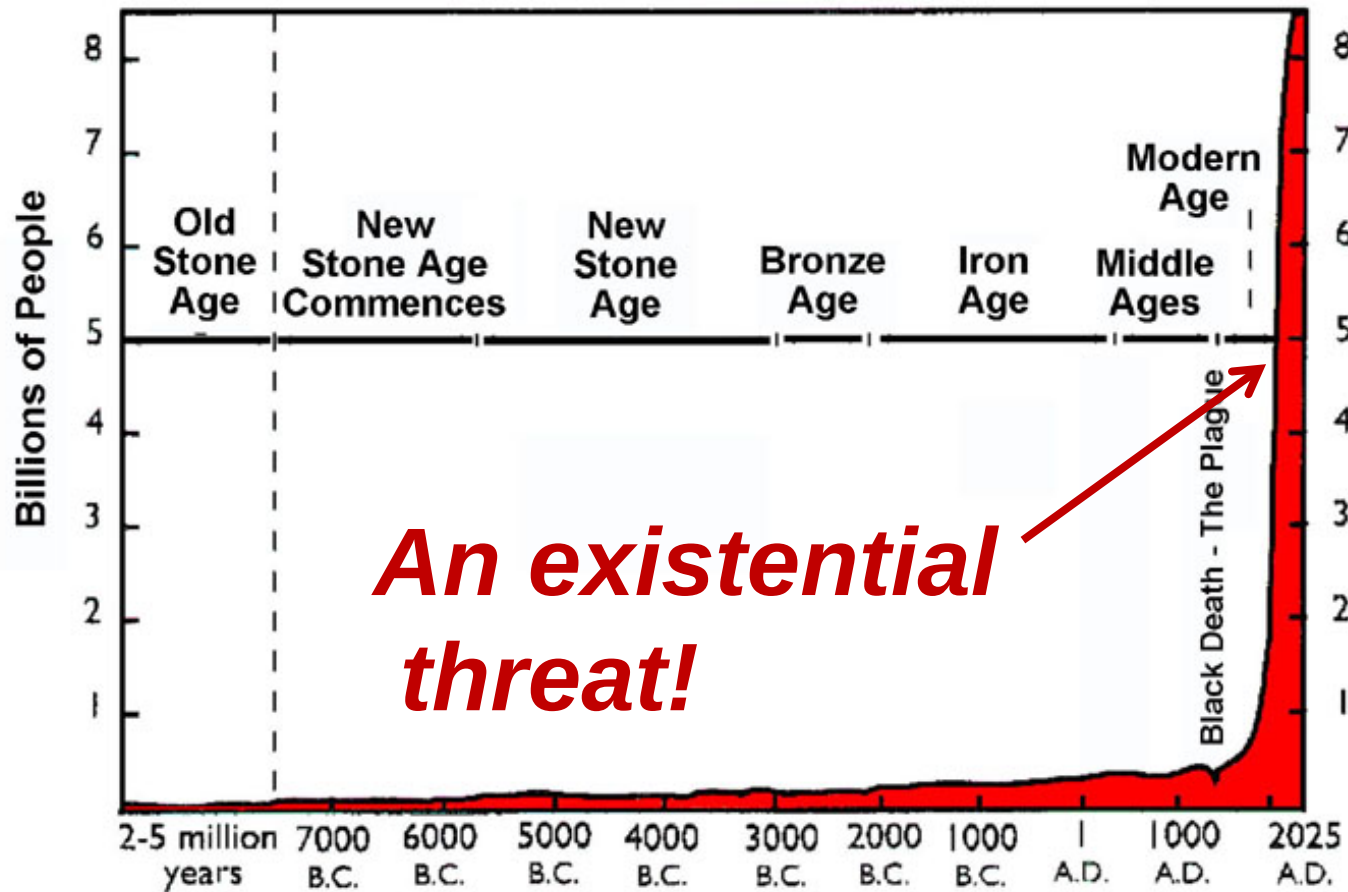
Peers and Mentors?

*Intrinsic motivation,
Design Thinking?*

What you Conceive

Why education must change

World Population Growth Through History



From "World Population: Toward the Next Century," copyright 1994
by the Population Reference Bureau

Why education must change



- Global, Complex, Multidisciplinary Challenges
 - **Security, Sustainability, Health, Enhancing Life**
 - *Unintended Consequences, systems thinking*
 - *Coupled Scientific-Social-Economic-Political-Religious*
- **Need New Kind of Education for Innovators**

Our traditional approach to higher education may be actually preventing us from producing innovators!

Broader View of Innovation

FEASIBILITY

*Engineering
and Science*

VIABILITY

*Business and
Economics*

DESIRABILITY

*Psychology, Arts,
Humanities, etc.*

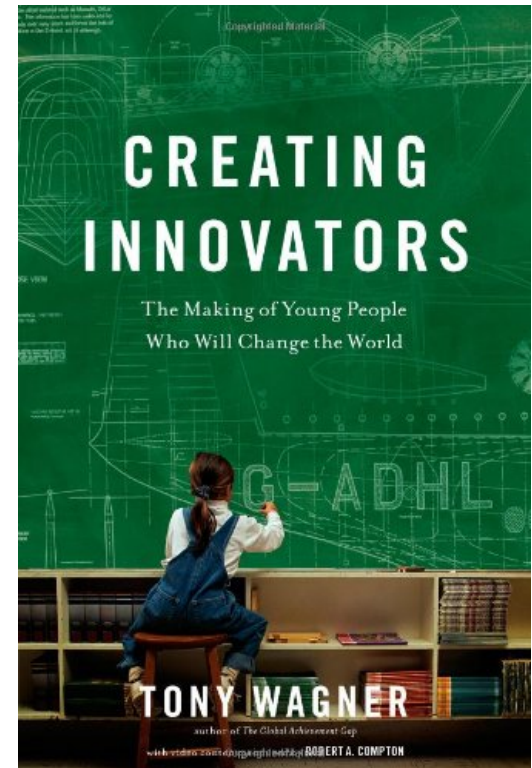
INNOVATION

***No amount of emphasis on narrow specialized courses
will produce the innovators we need!***

Lessons Learned

**To produce innovators,
we must change:**

- **Who we teach**
- **What we teach**
- **How we teach**



Learning to Improvise!

A New Culture of Learning

Traditional

Knowledge Transfer

“Can’t Do”

Follow Orders

Learn in Class

Learn Alone

Problem-based

New

Construct Knowledge

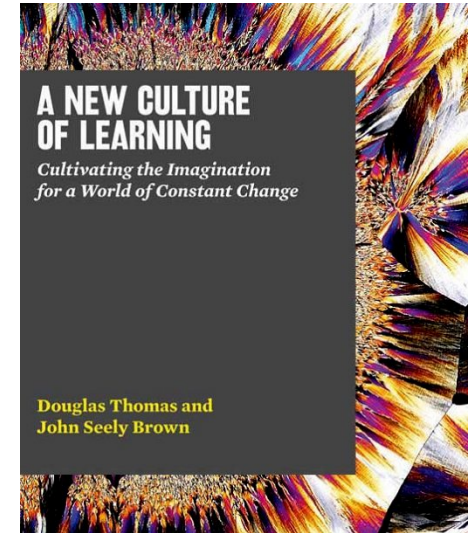
“Can Do”

Follow Your Passions

Learn 24 x 7

Learn in Teams

Design-based



↖ Pedagogy like
Graduate School

“For most of the twentieth century our educational system has been built on the assumption that teaching is necessary for learning to occur.”

21st century Innovators require more than specialized knowledge!

Attitude:

*More often than not,
your attitude* determines
your altitude in life*

**not your aptitude*



Importance of Mindset!

Attitudes, Behaviors, and Motivations:

- Entrepreneurial Mindset
- Ethical Behavior
- Teamwork, Leadership
- Global perspective
- Interdisciplinary thinking
- Creativity and design
- Empathy, social responsibility
- Employability skills



Educate to Innovate

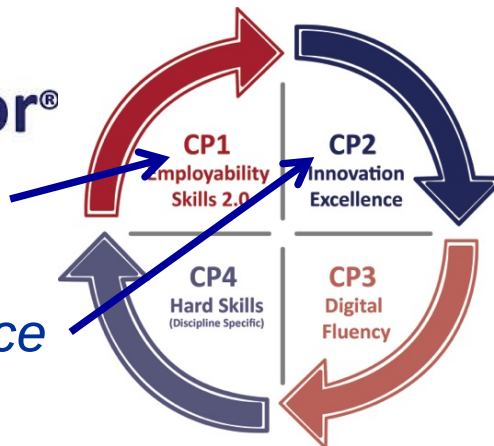


Capacity, Capability, Competitiveness

STEMconnector®

Employability Skills

Innovation Excellence



Importance of Mindset!

Attitudes, Behaviors, and Motivations:

- *Collaborative Mindset*
- *Entrepreneurial Mindset*
- *Interdisciplinary Mindset*
- *Global Mindset*
- *Ethical Mindset*



Educate to Innovate

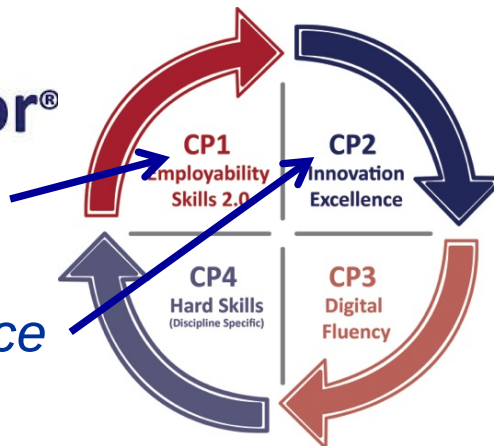


Capacity, Capability, Competitiveness

STEMconnector®

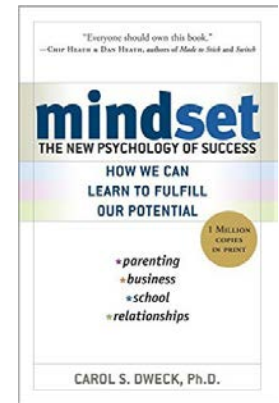
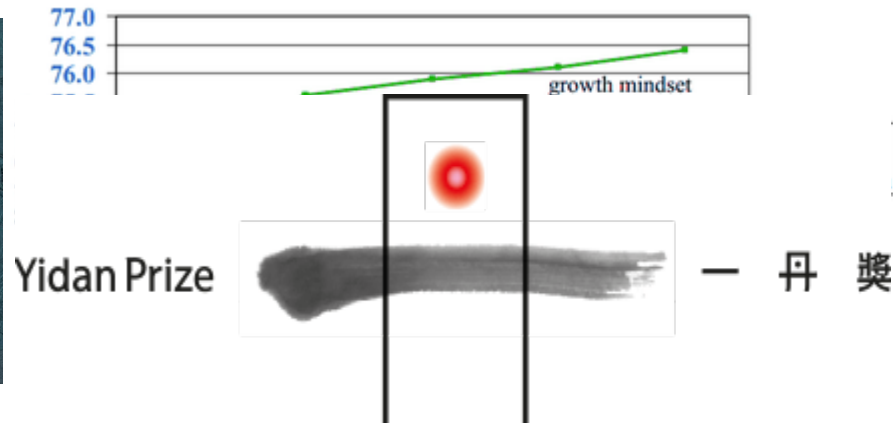
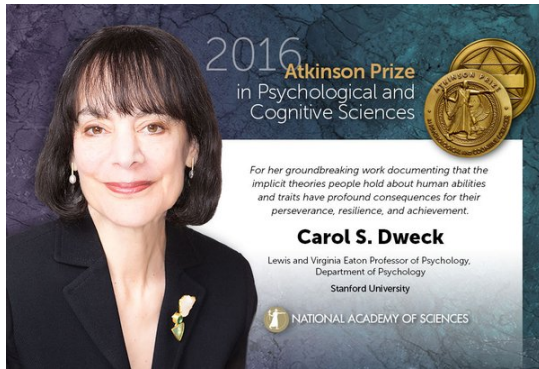
Employability Skills

Innovation Excellence

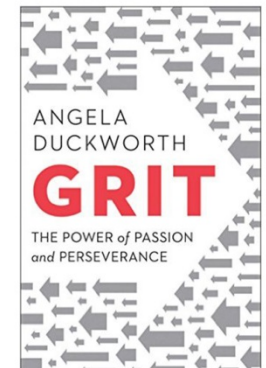


*It's NOT just about
content knowledge anymore!*

Mindset – can be defined, measured, and taught!



*Angela Duckworth, U. Penn
2013 MacArthur Prize*



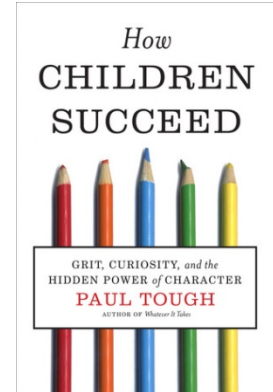
Mindset: Impact in Adults



*James Heckman
U Chicago
(Ctr for Economics
of Human Dev)*



*Nobel Prize in Economics
(with Daniel McFadden)
2000*



*Grit is often better
predictor of success than
knowledge or intelligence*



*“Hopeful faculty members spread hope among
their students, while cynical faculty members
spread cynicism”*

Mel Ramey – UC Davis

How Education Must Change In the 21st Century

21st Century: Education = ~~Job Preparation.~~

*21st Century: Education = Knowledge + Skills
+ Mindset*

*We must set the bar higher—not lower—and aim to prepare
students for life—AND their first job!*

What Knowledge and Skills?

Finding Things Out



Finding Things Out +
Making Sense of the World +
Envisioning What Has Never Been
and Doing Whatever It Takes to
Make It Happen(!)

Academic Disciplines



Learning Things That Matter +
Learning in Context +
Learning in Teams +
Making Things That Change Lives
= Learning How to Learn

How Is Mindset Shaped?

- *Identity*
 - *who do you believe you are?*
- *Agency*
 - *what are you confident you can actually do?*
- *Sense of Purpose*
 - *how will your life make a positive difference?*

“Making universities and engineering schools exciting, creative, adventurous, rigorous, demanding, and empowering milieus is more important than specifying curricular details,”

DR. CHARLES VEST, FORMER PRESIDENT OF MIT AND
OF THE US NATIONAL ACADEMY OF ENGINEERING.

