Future of Engineering Education in a World Based on Design and Systems

Thomas L. Magnanti

President, Singapore University of Technology and Design

Institute Professor, Massachusetts Institute of Technology

CSD&M Asia

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Basic Proposition:

All engineers should know something about systems and design and many engineers should know a lot

*Undergrads, Masters, Phd, Continuing Ed

US National Academy of Engineering's Greatest Achievements of the 20th Century


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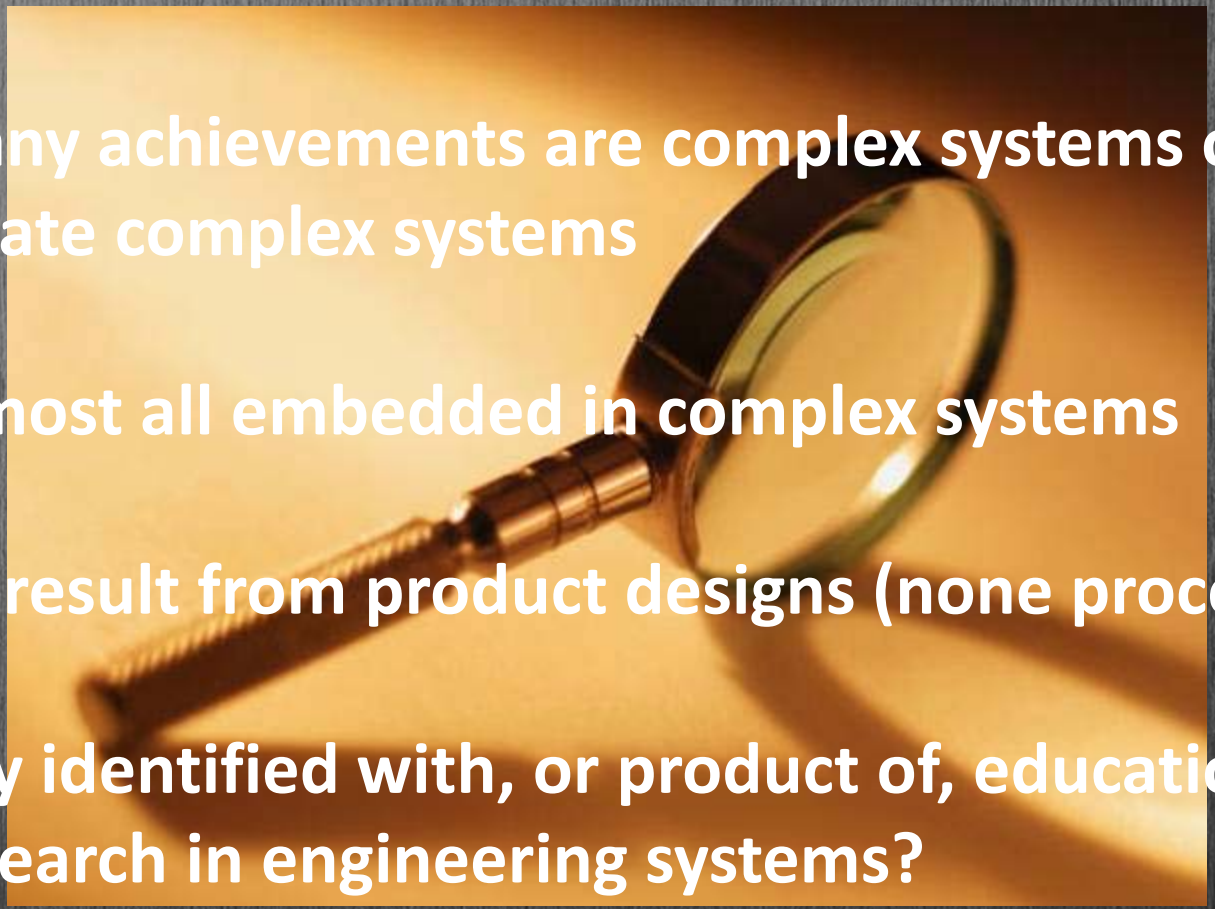
NAE Greatest Engineering Achievements of the 20th Century

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

Observations



- Many achievements are complex systems or create complex systems
- Almost all embedded in complex systems
- All result from product designs (none processes)
- Any identified with, or product of, education and research in engineering systems?

Today's Major Societal Challenges (All Systems)

Energy

Environment

Health

Food

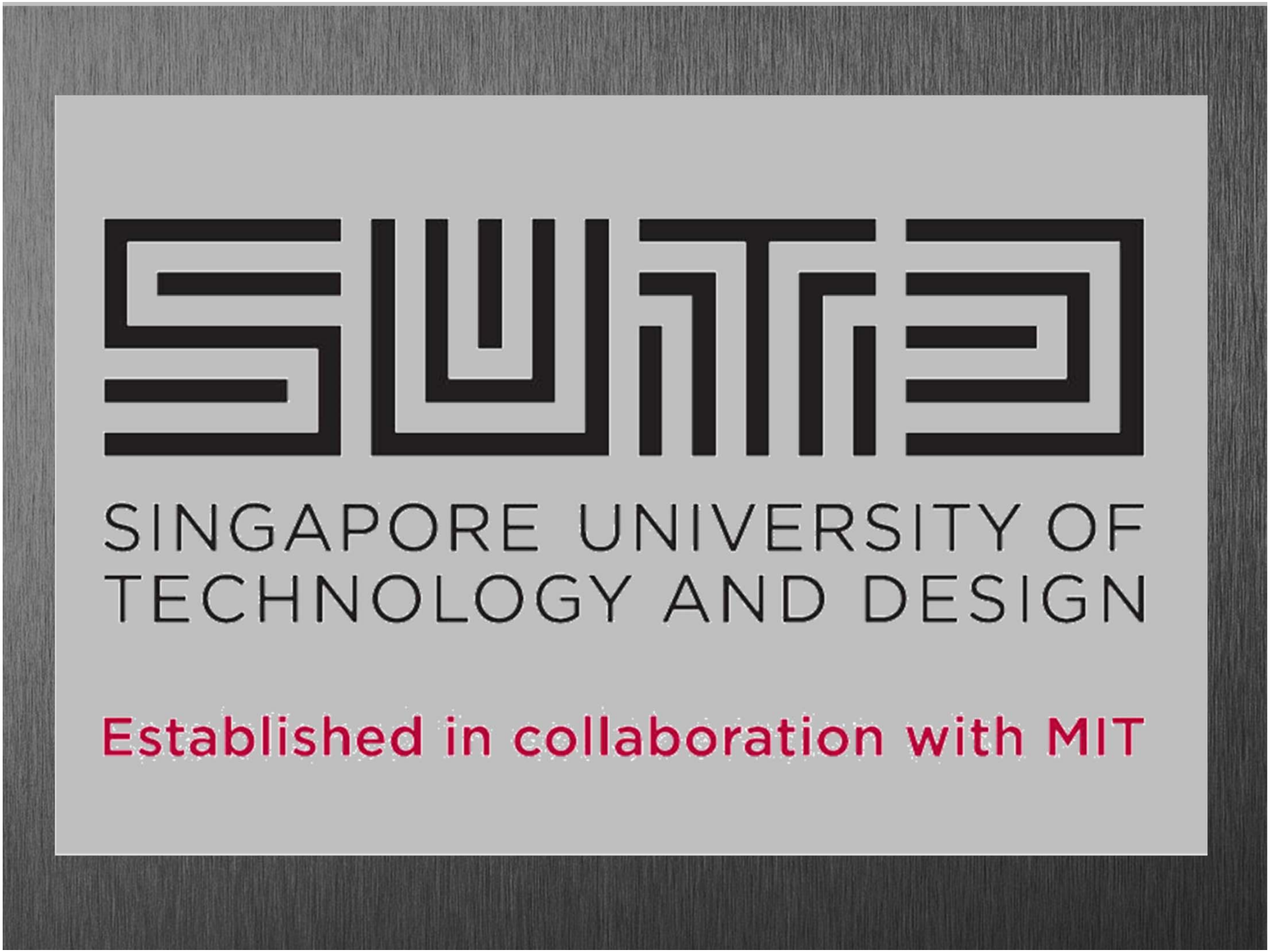
Water

Security

Transportation

Liveability


Undergraduate Education


SUTD
SINGAPORE UNIVERSITY OF
TECHNOLOGY AND DESIGN
Established in collaboration with MIT


SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN
Established in collaboration with MIT
Singapore University of Technology and Design Mission
Through integrated multi-disciplinary curriculum and research, and a focus on Design, advance knowledge and nurture technology-grounded leaders and innovators who will create a better world.

SUTD – An Overview

Global & Relevant

University with technology & Big-D design focus

Strong global partnerships

MIT Zhejiang University SMU

Outside-in Approach in research and education

Multi-disciplinary Culture

Broad footprint across Art & Science of Design - Scholarship, Practice, Entrepreneurship

Unique interdisciplinary, no walls, cross boundaries structure

Research-intensive

Unique Student Experience

Pedagogy, cohort-based, peer-support, Fifth Row

Diverse and inclusive student body (e.g. international students, high female ratios, etc)

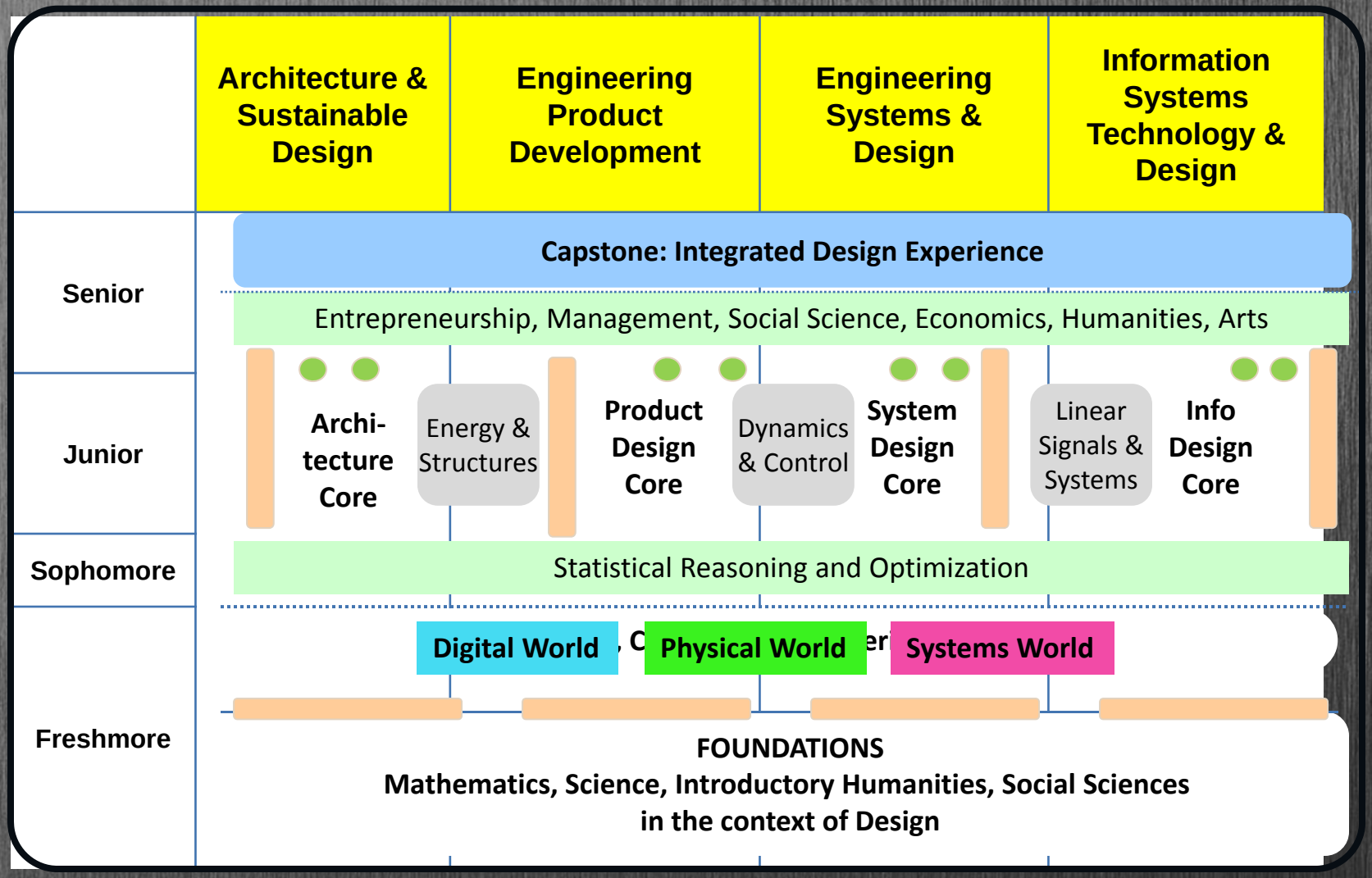
Engaging the world through research, industrial internships and entrepreneurship

Grounding on Technology and Design

Degree Structure

Outside-in approach

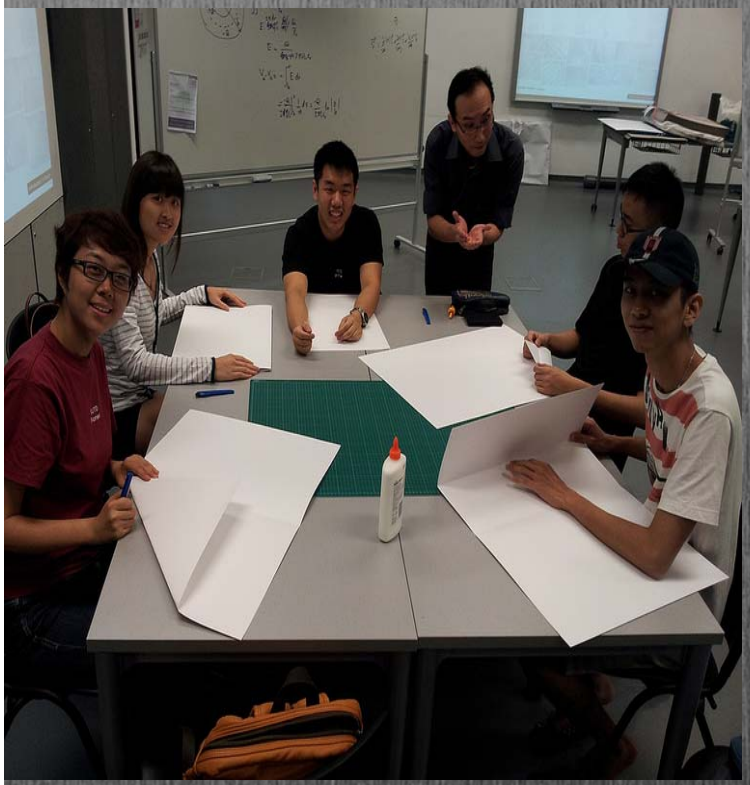
An Outside-In Curriculum



- *Four 12-unit subjects per semester (x 8 semesters) 22% humanities courses*


Intro to Design 3.007
SUTD
tchoukball
SAFETY FIRST

Idea Generation – Idea Development



Brainstorming

Mind-mapping

C-Sketch

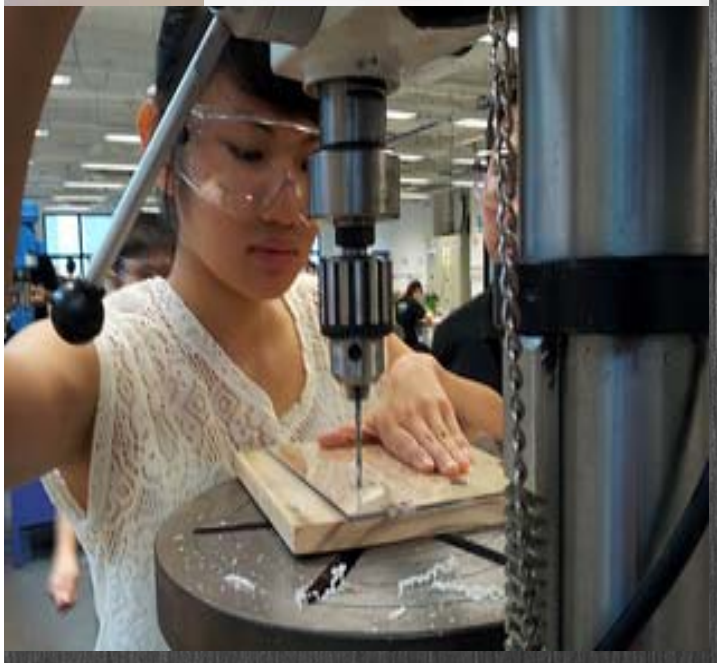
S.C.A.M.P.E.R

Bio-inspiration

Sketching

Abstraction

Design Development – Design Specification



Solid Modeling

3D Printing

Laser Cutting

Wood Work

Metal Work

Arduino Programming

Electronics Fabrication

Pedagogy

- Cohort-based learning communities
- Project-based and hands-on learning throughout the curriculum
- Learning objectives and measurable outcomes for ALL courses
- Lecturettes and videos
- OpenCourseWare
- Khan Academy type material and learning
- UROP, UPOP, UTOP

Active and Collaborative Learning

- Student-faculty ratio of 11:1
- Integrating lectures, recitations and laboratory sessions (Learn, Engage and Apply)
- Nurturing faculty, group learning & peer support
- Ready access to fabrication equipment

ESD Curriculum

Fundamentals

- Mathematics
- Physical sciences
- Biological Sciences
- Design
- Humanities

Analytics

- Optimization
- Probability & Statistics
- Simulation
- Network Science
- System Dynamics

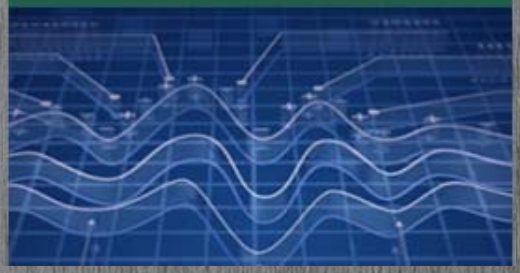
Economics, Management & the Social Context

- Economics
- Financial Decision Making
- Operations Management
- Quality and Reliability
- Organizations & People
- Project Management

Course Sequence

Focus Tracks

Business Analytics



Exploration of data to gain insights for business strategy and decision-making

Economics & Operations Research

Use of operations research and economic theory to model and solve complex problems in economics and businesses

Energy & Environment

Operations of energy / environmental systems & sustainability of our natural and built environment

Financial Services

Financial management, decision-making, trading, risk analysis and portfolio selection

Healthcare

Health care delivery, hospital management, healthcare economics and public policy

Supply Chain & Logistics

Design, planning and operations of supply chains

Telecommunication

Design of wireless and wired systems that are cost effective, scalable, intelligent through optimum resource allocation


Masters, PhD, and
Continuing Education

New Masters and PhD Programs

At MIT (as examples)

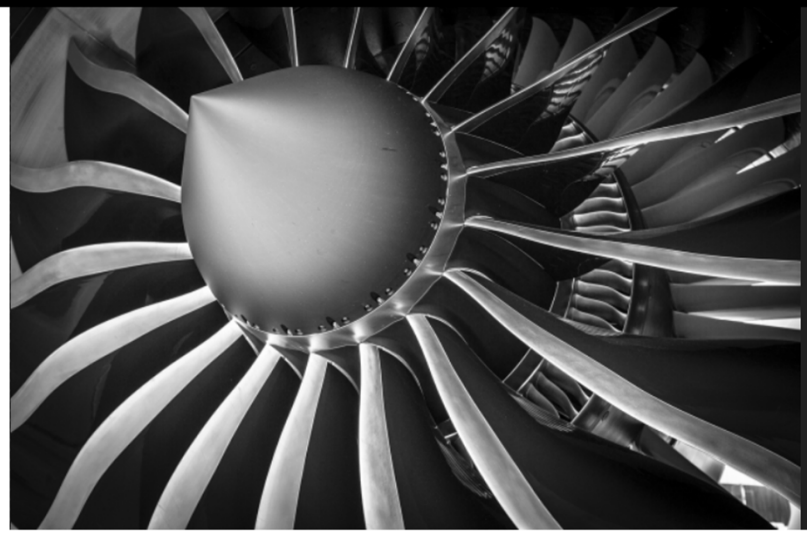
- Masters
  - Business Analytics (Operations Research Center)
  - Integrated Design and Management
    - Part of Systems Design and Management Program
- PhD
  - Doctoral program in Social and Engineering Systems
  - Long standing program in Operations Research

Continuing Education

MIT Example (Feb 18, 2016)

MIT News

Browse or Search



FULL SCREEN

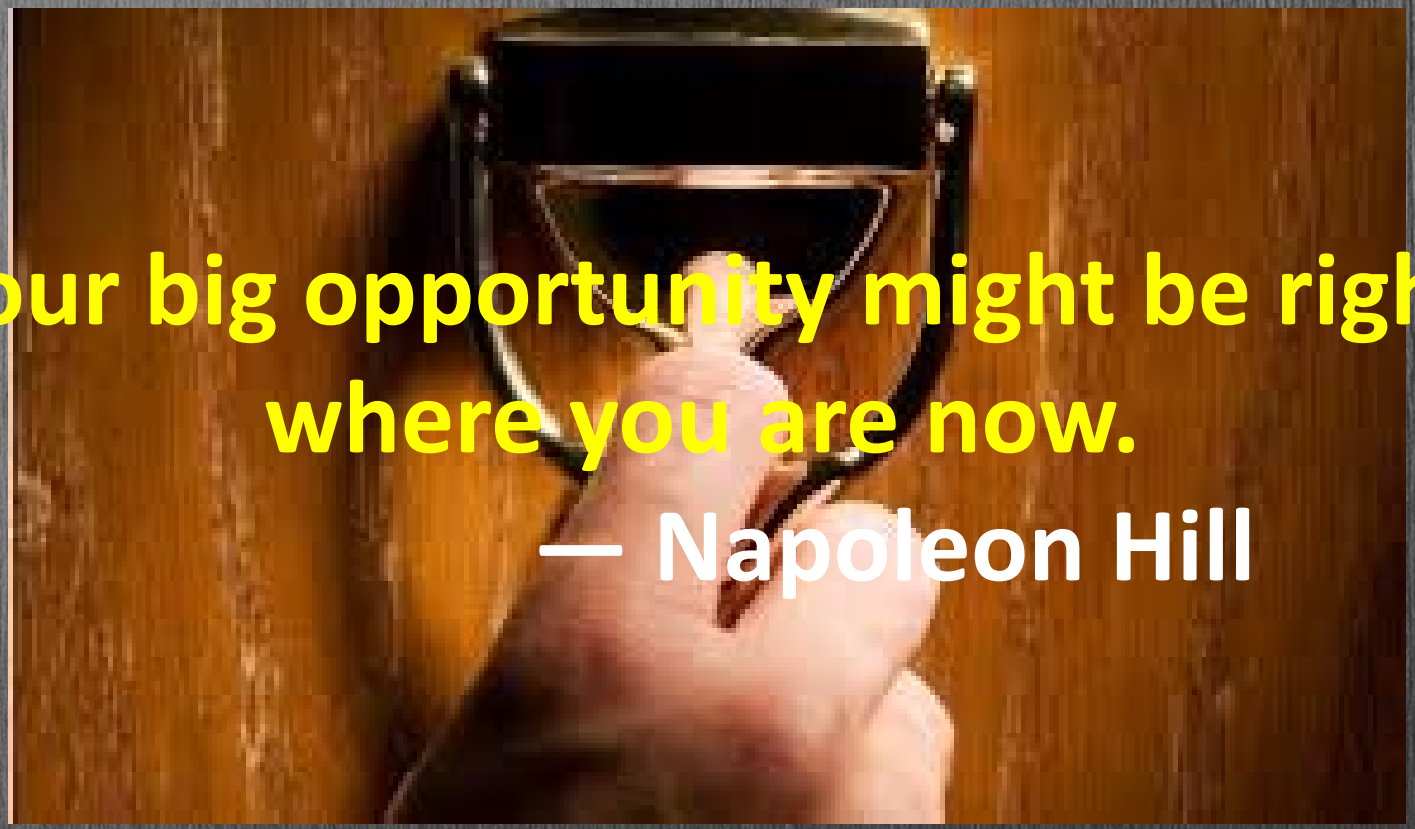
Four new courses, which will be delivered by MIT Professional Education via the edX platform, will marry the research and knowledge of MIT's world-renowned faculty with lessons and case studies in industry and government from Boeing and NASA professionals.

MIT, Boeing, NASA, and edX to launch online architecture and systems engineering program

Four-course program will train professionals in latest practices on models and methods to manage complex systems

Opportunities & Challenges

- **Opportunities**
  - Importance: plenty of critical issues
  - Breadth: touches almost everything
  - Awareness: increasing recognition of importance
    - Design and systems everywhere, not only engineering
- **Challenges (for systems)**
  - Public and potential students lack awareness and understanding
  - Viewed as “soft” by many engineering faculty
  - Complexity and lack of closed form solutions
  - Often, no physical artifact


Your big opportunity might be right where you are now.
— Napoleon Hill