The Singapore University of Technology and Design (SUTD)
- Nurturing technically-grounded leaders and innovators to serve societal needs through a multi-disciplinary, design-centric education and culture

Chong Tow Chong, Provost
Singapore University of Technology and Design
Content

• Designing a New University for the 21st Century
• Intellectual footprint & Curricula
• Pedagogy & Culture
• Conclusion
BIG Questions

If you were to create a world class university from scratch for the 21st century, what would you do?

Intellectual Footprint?
Organizational Structure?
Curricula and Degrees?
Teaching Approach?
Research Approach?
Facilities & Campus Design?
Use of Technology?
...?
Going back to history........

Evolution of engineering education

Industry Revolution
Evolution of Engineering Education


1st Industry Revolution 1760s-1900
Use of steam and mechanically driven production facilities

2nd Industry Revolution 1900-1970s
Electric Power driven mass production based on division of labor

Digital computing and communication technology for high productivity environment

Source: DFKI
Evolution of Engineering Education

3rd *Industry revolution*
Computer, IT & automation systems

2nd *Industry revolution*
electrical energy

1st *Industry revolution*
water and steam power

Source: 101 Things I Learned in Engineering
John Kuprenas
<table>
<thead>
<tr>
<th>1. Electrification</th>
<th>11. Highways</th>
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<tbody>
<tr>
<td>2. Automobile</td>
<td>12. Spacecraft</td>
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<td>3. Airplane</td>
<td>13. Internet</td>
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<td>5. Electronics</td>
<td>15. Household Appliances</td>
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<td>7. Agricultural Mechanization</td>
<td>17. Petroleum &amp; Petrochemical Technologies</td>
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<td>10. Air Conditioning &amp; Refrigeration</td>
<td>20. High-performance Materials</td>
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US National Academy of Engineering (NAE)
Evolution of Engineering Education

1st Industry revolution
- Water and steam power
- 3000BC to 1000BC

2nd Industry revolution
- Electrical energy
- 1800AD to 1900AD

3rd Industry revolution
- Computer & IT systems
- 1950AD to 2000AD

21st century?

Source: 101 Things I Learned in Engineering
John Kuprenas
The 21st Century

Multi-faceted, global and societally-focused issues

Rapid Urbanization

Ageing Society

Global Warming

Security

4th Industry Revolution 2015 –
Connected revolution: A digital transformation where everybody and everything is networked, sharing and processing information as a “huge brain”
To respond to these multi-faceted, global and societally-focused issues, are today universities keeping in pace in educating a new generation of graduates with global mindsets and relevant skills who are capable of providing practical, sustainable solutions that cut across traditional boundaries?
What we have learned over the last year makes clear that American higher education has become what, in the business world, would be called a mature enterprise: increasingly risk-averse, at times self-satisfied, and unduly expensive. It is an enterprise that has yet to address the fundamental issues of how academic programs and institutions must be transformed to serve the changing needs of a knowledge economy. It has yet to successfully confront the impact of globalization, rapidly evolving technologies, an increasingly diverse and aging population, and an evolving marketplace characterized by new needs and new paradigms.

Learning experience dominated by textbooks, lecturers, and exams.

45% of undergraduates show no statistically significant gains in critical thinking, complex reasoning, or written communications during their first two years of college.

Over four years, more than one-third of students show no real learning gains.

They might graduate, but they are failing to develop the higher-order cognitive skills that is widely assumed college students should master.

Three areas need to be addressed:

1. Breaking the siloes created by discipline/department structure

   Breaking down walls to enable interaction and collaboration

   Multi-disciplinary learning across boundaries
2 Develop skills and attitudes beyond book knowledge
Ability is what you’re capable of doing. Attitude determines how well you do it.

Lou Holtz
From Educate to Innovate

**Environment**

- Explicitly encourage innovation
- Provide freedom to think

**Skills and Attitudes**

- Creativity
- Dissatisfaction with the status quo
- Intense curiosity
- Ability to identify serendipitous moments
- Willingness to take risks and fail
- Passion
- Collaboration
- Ability to identify good problems/ideas
- Ability to solve problems at interface of disciplines
- Ability to communicate and sell an idea

**Experiences**

- Interdisciplinary collaborations
- Industrial experience and internship
- Identification and solution of open problems
- Mentorship
- Role models
- Upbringing that nurtures innovation
- Overseas immersion
- Working across nationalities and cultures

**Physical spaces for free/open/informal discussion**

From NAE Press Report: Educate to Innovate
3 Develop curricula, degree structure and pedagogy that can integrate multi-disciplinary learning with relevant skills and global experiences to solve the problems facing society
To nurture leaders and innovators by imbuing them with multi-disciplinary knowledge and skill sets for addressing the world’s challenges of today and tomorrow, and equipping them to be relevant to practice, informed and responsible citizens, and lifelong learners.
## SUTD – Our Strategy

<table>
<thead>
<tr>
<th>Global &amp; Relevant</th>
<th>Strong global partnerships MIT Zhejiang University</th>
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<tbody>
<tr>
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<td>Outside-In approach centered around Products, Systems &amp; Design</td>
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<tr>
<th>Multi-disciplinary Culture</th>
<th>Focus on Design through integrated multi-disciplinary curriculum and multi-disciplinary research</th>
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<tbody>
<tr>
<td></td>
<td>Unique interdisciplinary, no walls, cross boundaries structure</td>
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<td>Emphasis on Technology, Innovation, Entrepreneurship</td>
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<tr>
<th>Distinctiveness</th>
<th>Beyond teaching knowledge to teaching ways of thinking, how to analyze problems, how to come up with new solutions and possibilities (Skills &amp; Attitudes)</th>
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<tbody>
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<td>Develop graduates with ideas and solutions that have real-world impact and use</td>
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<tr>
<th>Unique Student Experience</th>
<th>Pedagogy, cohort-based, active, interactive and collaborative learning</th>
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<td></td>
<td>Time and space for passion and self development</td>
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<td>Diverse and inclusive student body (e.g. diverse backgrounds, high female ratios, etc)</td>
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<td>Engaging the world through research, internships and entrepreneurship</td>
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HOW?

Intellectual Footprint & Curricula
20th Century

Domain & Discipline-driven

Specific disciplines
- Civil engineering
- Mechanical engineering
- Electrical engineering
- etc...

Specific industrial segments
- Aeronautical engineering
- Chemical engineering
- Nuclear engineering
- Computer engineering
- etc...

21st Century

A cross-disciplinary, design-centric curriculum integrating knowledge, skills and attitude to serve societal needs
20th Century

Domain & Discipline-driven

Specific disciplines
- Civil engineering
- Mechanical engineering
- Electrical engineering
- etc...

Specific industrial segments
- Aeronautical engineering
- Chemical engineering
- Nuclear engineering
- Computer engineering
- etc...

21st Century

A cross-disciplinary, design-centric curriculum integrating knowledge, skills and attitude to serve societal needs
4 Pillars (what the world needs) ...
An Outside-In Design-Centric Curriculum

|-----------------------------------|--------------------------------|-----------------------------|----------------------------------------|

**Senior**
- Capstone: Integrated Design Experience
- Entrepreneurship, Management, Social Science, Economics, Humanities, Arts
- Architecture Core
- Energy & Structures
- Product Design Core
- Dynamics & Control
- System Design Core
- Linear Signals & Systems
- Info Design Core

**Junior**
- Statistical Reasoning and Optimization
- Digital World
- Physical World
- Systems World

**Sophomore**
- FOUNDATIONS
  - Mathematics, Science, Introduction to Design, Humanities, Arts and Social Sciences (HASS) in the context of Design

**Freshmore**
- Design projects
- Electives
- 22% HASS courses
- Emphasis of humanities, arts & social sciences
- BIG-D: Design everywhere
- Capstone: Multi-disciplinary design experience
It's in Apple's DNA that technology alone is not enough. It's technology married with liberal arts, married with the humanities that yields the results that makes our hearts sing.

(Steve Jobs, 2011)

Emphasis on humanities, arts and social sciences (HASS)

All students are required to take 7 classes in HASS

By incorporating HASS in the knowledge acquisition of technology and design, SUTD encourages students to acquire self-reflexivity, critical thinking, and communication skills so as to nurture leaders who can lead humane science and build a better society.
Design through conception, development, prototyping, manufacturing, operation – the full value chain

BIG Design

Every Subject (1D)

Across Subjects (2D)

pillars

Years (3D)
1D: Through hands-on and active learning activities.
2D: Making connections between subjects

30.001 Structures and Materials

Energy harvesting

30.002 Circuits and Electronics
3D: Subjects across 2 Terms

- Circuits & Electronics, Term-4
- EM & Applications, Term-5
Capstone Project

A capstone project is an industry/society-focused, multi-disciplinary project for senior-year students to apply the design principles, concepts and techniques they have learned to solve real-world problems as part of a multi-disciplinary team.
Nature of Capstone Project

To include an extensive range of technological design skills and architecture/engineering knowledge such as:

- **Identification of needs**
- **Transforming needs into technical specifications or design strategies**
- **Applying modelling techniques and evaluating design alternatives**
- **Using teamwork to resolve the challenges in designing and producing tangible outcomes**
HOW?

Pedagogy & Culture

• Cohort-based, Active and Collaborative Learning
  • Time and Space for Self
Lecture Hall Style Teaching
Passive and Impersonal

Retention: 1st 10 mins: 70%
last 10 mins: 20%

Paying attention: 40%

(McKeachie, 1986)

(Pollio 1984)
Course Overload

Drinking From the Fire Hose

No life outside the classroom
• **Cohort-based, Active, Interactive and Collaborative Learning**

  Creative thinking, Intense curiosity problem solving, multi-disciplinary mindset, team-work and collaboration

• **Time and Space for Self**

  Pursue passion and interests
  Get out of comfort-zone
  Leadership and entrepreneurship
Active and Interactive Learning

- Lectures
- Tutorials/Home work
- Labs
- Mini-Lectures
- Activities
- Mini-Lectures
- Activities
- Mini-Lectures

Time:
- 60 min
- 1 week
- 2 weeks
- 120 min

Methods:
- Group learning
- Concept questions
- Problem solving
- Design projects

Learn
Engage
Apply
Active, Interactive and Collaborative Learning

- Sustained concentration level
- Group learning & peer support
Active and Collaborative Learning

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

What students say:

“I have not left my classes with a single doubt.”

“I feel like a more mature thinker! And I’m better able to see the bigger picture.”

“I really appreciate [the faculty’s] commitment to teaching!”
11:1 STUDENT-FACULTY RATIO. COHORT-BASED. DEDICATED CLASSROOM.
Hands on, Active Learning
PEER SUPPORT. TEAM-BASED LEARNING.
Time and Space for Self

Pursue passion and interests
Get out of comfort-zone
Leadership and entrepreneurship
On-campus living @ 6°

Student Activities through the Fifth Row

Outside-in curriculum
4 courses per semester

Fifth Row. 6° Residential Stay. Time and Space for Self.
Not an afterthought.

- Independent activity period (every January)
- Free every Wednesday and Friday afternoon
- Self-initiated clubs/societies
- Entrepreneurship, Research (UROP*)

*UROP: Undergraduate Research Opportunity Program
Co-curricular activities are often an afterthought; at SUTD, they are turned into a first-class activity – called the Fifth Row

Fifth Row activities are designed to foster creativity:

- Creative thinking: UROP*
- Professional practice: UPOP*
- Self-powered creativity: Clubs & Teams
- Company creation: Entrepreneurship
- Student Government (Root): Leadership
- Having Fun: Hacking, dancing, living

* UROP – Undergraduate Research Opportunities Program; UPOP – Undergraduate Practice Opportunities Program
# SUTD Entrepreneurship Pathway

<table>
<thead>
<tr>
<th>Term 1</th>
<th>Term 2</th>
<th>Term 3</th>
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<tbody>
<tr>
<td>JAN – APR</td>
<td>MAY – AUG</td>
<td>SEP – DEC</td>
</tr>
<tr>
<td>TERM1 STARTsomething</td>
<td>TERM2 BUILDsomething</td>
<td>TERM3 LAUNCHsomething</td>
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<thead>
<tr>
<th>Term 3</th>
<th>Term 4</th>
<th>Term 5</th>
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<tbody>
<tr>
<td>MAY – AUG</td>
<td>SEP – DEC</td>
<td>JAN – APR</td>
</tr>
<tr>
<td>Break/ Exchange/ Internship</td>
<td>hackathons/ Mentoring/ Incubation</td>
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<tr>
<th>Term 5</th>
<th>Term 6</th>
<th>Term 7</th>
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<tbody>
<tr>
<td>JAN – APR</td>
<td>MAY – AUG</td>
<td>SEP – DEC</td>
</tr>
<tr>
<td>Break/ Exchange/ Internship</td>
<td>Entrepreneurship Capstone Preparation Bootcamp</td>
<td>Entrepreneurship Capstone</td>
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<tr>
<th>Term 7</th>
<th>Term 8</th>
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<tbody>
<tr>
<td>JAN – APR</td>
<td>MAY – AUG</td>
</tr>
<tr>
<td>Entrepreneurship Capstone</td>
<td>Entrepreneurship Capstone Demo Day</td>
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**Startups**

- 13
- 7 Incubating @ SUTD

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### Create4Good (Social Innovation) Pathway

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<tr>
<th>JAN – APR</th>
<th>MAY – AUG</th>
<th>SEP – DEC</th>
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<tbody>
<tr>
<td>Bootcamp &amp; Call for proposals</td>
<td>Team forming leading to semi final selection</td>
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- Company formation
- Prototype & business model development
- Final Judging
- Top 3 teams given resources to further develop business
FIFTH ROW - More than 84 student organisations ranging from Performing Arts, Culture and Language, Engineering and Design to Community Service, the Arts, and Sports
UROP Project: The Omiboard (Electric Skateboard)

About 50% of Students participated in UROP

Research Opportunities

Faculty and students work together on creative projects

Great starting point

Apply theory into practice

Phases of research activity

Developing research plans, generating and analyzing data etc
Preparing Students for Future Careers

INTERNSHIPS (16 weeks) CAREER CENTRE

Over 700 companies in partnership with SUTD

UPOP (career preparation courses), industry recruitment talks, etc.

POSTGRAD

Masters and PhD Programme

POTENTIAL CAREERS ACROSS DIVERSE SECTORS

Architecture  FMCGs  Finance  Consultancy  Telecomms

Energy/ Environment  IT/ Software  Logistics  Advanced Manufacturing
Conclusions
The 21st Century

Multi-faceted, global and societally-focused issues

Rapid Urbanization

Ageing Society

4th Industry Revolution 2015 –
Connected revolution: A digital transformation where everybody and everything is networked, sharing and processing information as a “huge brain”

Global Warming

Security
Engineering education must continue to evolve to respond to the new challenges.

These include:

(1) Greater flexibility and diversification offered to students in their engineering studies (multi-disciplinary)

(2) The blending of on-campus active learning with off-campus online learning to scale up

(3) Curricula that bring together cross-disciplinary learning, human-centred engineering and global outlook
Summary

1. We need a new, innovative pathway for nurturing technically-grounded leaders for a changing world.
2. SUTD has opted to try a different educational model of staying on the global front and staying relevant.
3. Will the SUTD model turn out to be an innovative and timely response to new needs and new paradigms for the 21st century?

To put new wine into new bottles
Our 1\textsuperscript{st} batch of graduates are well received by wide industry sectors and graduate schools.

Example of universities offering our students places in graduate studies:
Think Big, Think Far....

“The quality of our expectations determines the quality of our actions”
- Andre Godin..
"You never conquer the mountain, You only conquer yourself."

Jim Whitaker
First American who climbed Mount Everest
Thank You

Nurturing Technically-gounded Leaders and Innovators
Creative ● Passion for technology and design ● Multi-disciplined ● Risk-takers

“Someone with passion, ability and dreams to go and do something that is going to change the world.”