The Role of Engineering Education in Singapore’s Economic Transformation

By

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Singapore Vital Statistics

- ≈ 716 sq. km
- Cosmopolitan multi-cultural city-state

- Population of about 5.31m:
  - Chinese 74%
  - Malays 13%
  - Indians 9%
  - others eg, Arabs, Eurasians

- Singapore residents: 3.8 m

- A former British colony, now is an international city with a large expatriate community

- 13m visitors yearly
Land area before 1960: 581 sq. km
Economy and Trade


- Major industries: oil refining (3rd in world), pharmaceutical, electronics, precision engineering, offshore engrg

- Major services: wholesale/retail trade, hospitality, financial, business

- One of the 5 busiest port in the world, external trade is 3 times the size of GDP

- Fourth biggest financial centre in the world

- **5,000 MNCs** use Singapore as a base for global operations

- Accounts for 40% of ASEAN trade, and 40% of the investment in the region
Singapore ranked 9th: 2012 GDP (Nominal per capita = USD $52,052). USA (USD $51,704), China (USD $6,071)

Source: Based on the IMF figures. If no number was available for a country from IMF, CIA figures were used.
URL: http://en.wikipedia.org/wiki/List_of_countries_by_GDP_(nominal)_per_capita#cite_note-1
Singapore ranked 3rd: 2012 GDP (PPP= USD $60,799). USA (USD $51,704), China (USD $9,055)

Countries by 2011 GDP (PPP) per capita, based on World Bank figures; if no IMF/World Bank figure was available for a country, the CIA figure was used.
URL: http://en.wikipedia.org/wiki/List_of_countries_by_GDP_(PPP)_per_capita
Caveat

- A country’s gross domestic product (GDP) measures “everything except that which makes life worthwhile”.
  
  ---Robert F. Kennedy

- GPI (Genuine Progress Indicator), a metric for life satisfaction which includes subjective measures of well-being, may be more useful.

Possible Reasons for Divergence

- Wealth **Creation** vs Wealth **Management**
  - Wealth management increases GDP but not necessary wealth
  - Engineers are wealth creators but insufficiently rewarded
    - Efficiency = output/input: Comparison of TV and Property clearly shows the discrepancy

- Unequal distribution of wealth leads to widening of rich-poor gap and increase in Gini coefficient (0.478 in Singapore, 0.256 in Norway in 2012), and flattening of GPI
World distribution of Gini Coefficient
Consequences of unequal reward system

- Difficulty to attract good students to engineering as more are drifted towards finance
- Many engineering graduates do not stay in engineering profession
- Decline in manufacturing industries and rise of service sector
- The economy will suffer in the long term as it needs wealth creation to support wealth management
Possible Solutions

- Enhance wealth creation through innovation and enterprise
- At national level, a Research Innovation and Enterprise Council (RIEC) chaired by the Prime Minister was formed in 2006. It comprises Cabinet Ministers and distinguished local and foreign members from the business, science and technology community
- At faculty level, an Institute for Engineering Leadership (IEL) to promote innovation and enterprise was formed in 2011
Possible Solutions

Research
(NRF 5 year-budget: US$12.5 Billion)

Knowledge
Patents
IP

Innovation & Enterprise
IEL Supports National Strategies

Innovation

Entrepreneurship

Productivity
(through innovation)
What IEL wants to achieve

Supporting current opportunities  Creating new opportunities

A strong base of engineer-leaders that can support current opportunities and create new ones
Engineer-Leaders are ...

- *Individuals* who are *strategic systems thinkers* and *value creators*. They can *identify market and technology opportunities* and *engage people around them* to deliver *profitable growth with social impact*.

- *Enterprises* that are *differentiated*, fast growing, *scalable* and visible.
Engineer-Leaders have

Technical depth

Strategic outlook

Business savvy
Engineer-leaders can generate... 

... New ideas

Translate...

... Ideas to innovations

Transform...

... Innovations to wealth opportunities
Innovation and Enterprise Development

Objective:
Teaching students through action how to leverage technology into start-ups and unique products.

Implementing unit:
Enterprise Development Lab (EDL)
Innovation and Enterprise Development

- Focusing on Value Creation
- Nurtures both types of innovation & entrepreneurship

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\text{(TECHNOLOGY} \rightarrow \text{MARKET} = \text{IMPACT})
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EDL’s Modules: Experiential Learning for Leadership Development and Value Creation

**Technology to Market**

- **Technology Venture Lab**: Catalysing mindset change in researchers.
- **MarketZoom**: Strengthening commercialization strategies.
- **TechLaunch**: Finding and validating value for selected NUS technologies.
- **Venture Funding Lab**: Identifying ways to fund a new venture.

**Market to Technology**

- **Market Gaps**: Identifying and analyzing for potential technology application.
- **Frugal Innovation Lab**: Creating prototypes to address identified market needs.
Innovation and Enterprise Development

Bridging the Innovation Gap

Technology
- PhD Students
- Engineering Graduate Students

ED Lab

Business
- Entrepreneurs-in-Residence
- Industry Experts, VCs
- Business Students
Innovation and Enterprise Development

From Idea to Impact – Company Pipeline Creation

Info Sessions

Step 1: Technology Venture Lab

Selection

Step 2: MarketZoom

Step 3: TechLaunch

Validation

Step 4: Venture Funding Lab

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Scalable Start-up with a validated model
Innovation and Enterprise Development

- TECHNOLOGY VENTURE LAB

Objective – expose NUS researchers to the process of creation a commercialization strategy for their technologies
- Action learning weekend experience
- Industry experts supervise small groups of researchers
- Required presentation to a group of experts at the end of the lab
- Product – ability to articulate technology’s commercial potential and societal impact

1. MINDSET CHANGE
Innovation and Enterprise Development

- MARKETZOOM

Objective – strengthen commercialization strategies for technologies applying for Proof-of-Concept grants
  - Action learning over 3 weeks
  - Done by teams of engineering and business graduate & PhD students who go through value definition and validation, making money & business models, Go-to-Market strategies
  - End Result – clear definition of technology’s commercial potential and societal impact

2. CLARIFIES TECHNOLOGY DEVELOPMENT TARGETS
Innovation and Enterprise Development

- TECHLAUNCH

- Objective – develop & VALIDATE commercialization strategies for selected NUS technologies
  - Done by teams of engineering and business graduate and PhD students (4-5 on each team)
  - Industry experts supervise each team
  - PI designates a PhD or graduate student to provide technical input about the innovation
  - Created around “Management of Extreme Uncertainty” principles
  - Business plan presentation to potential investors

3. DEVELOP & VALIDATE COMMERCIAL POTENTIAL
More About TechLaunch

About the Course:

- A unique experiential module in which students develop a start-up based on a selected technology created at NUS.
- Students work in cross-disciplinary teams of graduate and Ph.D. students from the Faculty of Engineering & School of Business.
- The *objective* is for students to learn how to search for the maximum value creation in an iterative manner as start-ups do in the real world.
- The *goal* is to get commitments, customers and orders at the end of the semester if at all possible.
Real experiences – pitching to industry and business experts
Some of the NUS Technologies in TechLaunch...

**HumidFree** provides a unique **membrane dehumidifier** system that decreases inlet air humidity by half thus dramatically reducing the energy required to cool a building.

**Nusmetics** is commercializing novel **micro-needles** developed at NUS. The first product is an effective overnight patch for reducing cellulite.

**Structo** revolutionizes rapid prototyping by providing a **3D printer** that is 10 times faster than current to the leaders of the manufacturing industry.

**ReVoice** equips surgeons with a medical device for in-office **tracheo-esophageal puncture** (TEP) surgeries for immediate voice restoration.

**Greenus** is commercializing a **patented bacteria** and simple process to convert organic feedstock into useful green products. The first product is **bio-succinic acid** produced out of sugarcane bagasse.

**StemDerm** revolutionizes **skin testing in cosmetics** and pharmaceutical industries by providing real life human skin derived from stem cells assuring consistency and thus speeding time-to-market for cosmetics products.

**HomeRehab** system enables patients to perform **prescribed rehabilitation exercises** from home and measures their progress. Therapists can focus on customizing treatment thus allowing them to see 3 times more patients than before.

**BioCycle** produces **bio diesel** made out of waste grease using a **unique patented biocatalyst** for the Asian emerging economies hungry for energy.

**Luminicell** offers a **unique cell-tracing product** to the pharmaceutical industry that enables ten times higher visibility and dramatically longer tracing of cancer cells than any other product on the market today.
ReVoice
Providing a novel user-friendly medical device assisting surgeons to safely and efficiently restore patient’s voice

Current Surgical Procedures and Problems
The tracheo-oesophageal speech (TES) provides the best recovery of voice and is the gold standard for voice rehabilitation. In order to achieve TES, tracheal-oesophageal puncture (TEP) and voice prosthesis implantation are currently used, which causes problems:

- Large trauma
- Difficulty in measurement of voice
- Long procedure time
- Slower healing
- Discomfort for patients

Solution and Value Proposition
Our Device Provides a Safe and Efficient Way

- Patients
  - Immediate voice restoration
  - Less discomfort

Key Benefits
- 10 minutes procedure
- Immediate voice restoration

Market Size and Business Model
Projected Revenue of $100 Million in 5 Years

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<th>Region</th>
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<th>Reachable cases</th>
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ReVoice Risk

- Device is new
- Stabilisation before each

Contact

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Innovation and Enterprise Development

• VENTURE FUNDING LAB

• Objective – focuses on start-up equity funding.
• Challenge the teams to identify creative ways to fund the company by getting out into the market and ‘pounding the pavement’.
• Teams/companies that are selected for the Funding Lab satisfy four criteria:
  1. Know their customers and their needs and have validated that their product addresses them (customer desirability).
  2. Offer unique value and have proof to this effect (technology feasibility).
  3. Have validated assumptions in their business model and can prove that the product will make money (business viability).
  4. Have a great team that is passionate about the start-up.

4. GET MONEY
Creating Impact in Emerging Markets

Info Sessions

Step 1: Growth Lab

Selection

Step 2: Frugal Innovation Lab

Validation

Funding/SME

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Innovation and Enterprise Development

- **GROWTH LAB:**

  - **Objective** – identify issues and define problem statements for emerging market needs in SE Asia.

  - “On the ground” assessment in identified markets based on prior market research of potential interest areas.
  - Defining industry problem statements based on this research.
  - Identifying technical partners both within and outside NUS.
Innovation and Enterprise Development

- **FRUGAL INNOVATION LAB:**
  - [Launched in Semester 1 AY 2012/2013]

- Objective – create prototypes to address Emerging Market needs in SE Asia based on problem statements defined in Growth Lab
  - Undertaken by teams of engineering and business graduate students.
  - Students prototype, then test in local markets.
A flagship technopreneurship learning platform that aims to **nurture** a community that redefines **innovation and venture creation** in universities.

Hosts challenges featuring **real industry problems** faced by organizations, institutions and companies around the world and bring together **passionate students** from diverse backgrounds to create **disruptive solutions**.

InnoVenture

- Launch of the inaugural InnoVenture competition.
  1. A student competition run by students for students.
  2. Teams work on problems statement provided by companies.
  3. Undergo bootcamps on technopreneurship and prototyping.
  4. Winning teams get prototyping money and proceed to the next stage.
  5. Students get credits for their involvement; learning by doing.
- Hands-on, competitive, experiential learning module that is ideal for students to gain insight, confidence, and basic capabilities about the theoretical and practical aspects of technopreneurship.
InnoVenture

- Providing problem statements for the students to work on, expertise to guide the students along the way and sponsorship to support the student initiative.

**HEALTHY NUTRITION ON-THE-GO**

**NESTLE**

Active adults between the ages of 55 to 65, aka Good Lifers, are interested in maintaining their energy and wellbeing. They know that they need to pay attention to their nutrition as much as possible. However, the normal fast paced life makes fulfillment of this objective difficult.

The challenge is to design a product or service that would allow these Good Lifers to enjoy the benefits of a healthy and balanced nutrition “on the go”.
How were they impacted?

Learning to take risks

Getting hands dirty

Solving problems together

Becoming part of an entrepreneurial community
The InnoVenture “circles of influence”

Companies have the opportunity through interaction with students to assess potential talent at an early stage.

Students hone their hard skills in value creation activities.

Students learn the hard way why EQ is important.

Students are attracted to the opportunity to solve real problems.

NUS has a differentiating proposition to draw talented students into engineering.
Observation 1:

Leadership potential is best developed through EXPERIENTIAL LEARNING

- Not just project work
- Leadership potential development requires situations that are
  - Real world cases
  - Where students **CAN TAKE CHARGE** of **DELIVERING SOMETHING OF VALUE**
  - Where they **HAVE VESTED INTEREST**; and
  - Have **POTENTIAL FOR CONTINUATION** not just learning
Observation 2:

REAL EXPERIENTIAL CASES & REAL ENVIRONMENT are required for practising REAL LEADERSHIP
IEL: Creating experiential cases & environment

- Safe to take risks
- Create value
- Take charge

Develop Engineering Leaders

Develop & Strengthen Enterprises

VALUE CREATED

LEADERS EMERGE
Observation 3:

Leadership development has to provide SOFT and VALUE CREATION SKILLS in addition to hard (technical) skills.
Engineer-Leader Skill Gaps
IN VALUE-CREATION AND SOFT-SKILLS
IEL develops and provides a vibrant connected ecosystem for the development of engineer-leaders.
Thank You