Economy, Technology, and Education

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Economy

- Creation of Wealth
- Distribution of Wealth
Technology

- Application of Scientific Knowledge to the Solution of Practical Problems
Education

- Discovery of Knowledge
- Production of Human Resources
Education

Economy

Technology
Economy: Creation of Wealth

- Labor Force = Wealth
- Natural Resources = Wealth
- Technology = Wealth
Labor Force = Wealth

- Large Population
- Slaves
- Expatriates, Migrant Workers
- Sweatshops
- Steam Engine: First Industrial Revolution
Natural Resources $\equiv$ Wealth

- Gold, Coal, Iron, Oil, ....
- Territory, Colony
- Cartels
Technology = Wealth

- Aerospace, Communication, Information, Medical,….
- Fashion, Music, Literature,….
- Knowledge
- Talents
Wealth
Technology

Mutual Enhancement

Wealth
Technology

Mutual Enhancement
Micro-electronic Industry
(An Example of High Tech Industry)

Micro-electronic Industry: US$1,000 billion

- personal computers,
- cellular phones,
- networking equipment,
- video games,
- cameras

Supported by

Semiconductor Industry: US$200 billion

- microprocessors,
- micro-controllers,
- DSPs,
- integrated chipsets
Making Sausages

Piglet → Pig → Pork → Sausages → Packaging
High Tech Industries

- Rapid advancement in technology
- Low cost products
- Unbounded market needs
- Short product life
- Capital intensive
- Brain power intensive
Rapid Advancement in Technology (Semiconductor Industry)

Thickness of skin is 100 $\mu$m
Diameter of a piece of hair is 50 $\mu$m
Finger nails grow by 1 $\mu$m in 10 minutes
Rapid Advancement in Technology
(Semiconductor Industry)

Transistors Per Die

Memory
Microprocessor

Pentium® II Processor
Pentium® Processor

Pentium® Pro Proc.

Memory
Microprocessor


'70 '73 '76 '79 '82 '85 '88 '91 '94 '97

4004 8080 8086 i386™ CPU i486™ CPU

1K 4K 16K 64K 256K

1K 4K 16K 64K

1M 4M 16M 64M

Memory
Microprocessor
Low Cost

(Semiconductor Industry)

- A transistor cost $30 in 1960
- 8080 (5,000 tx) cost $150 in 1974: 3 cents/tx
- Pentium-II (7,500,000 tx) cost $225 in 1997: 0.003 cents/tx

- 1,000 fold decrease from 1960 to 1974
- 1,000,000 fold decrease from 1960 to 1997
Technology

- rapid advancement in technology
- miniaturization, low cost
- cheaper, smaller, faster systems
- greater market needs

Moore's Law
Capital Intensive
(Semiconductor Industry)

Million US$
Customization and Short Product Life

Complex Design Work

Short Design Cycle

Brain Power

Design Power
Brain Power: Productivity Gap
(Semiconductor Industry)

Chip Capacity and Designer Productivity

Complexity growth rate 58% per yr.
Productivity growth rate 21% per yr.
Headcount is growing and growing and growing.

Moore's Law also applies...
Development of High Tech Industries — Needs

- **Technology**
  - Research
  - Development
  - Technology transfer
  - Spy, Pirate

- **Human Resources**
  - Management
  - Technical

- **Facilities**
  - Capital
  - Infrastructures
Development of High Tech Industries — Roles

- **Industry**
  - Industrial laboratories
  - Funding research at universities

- **Government**
  - Government laboratories
  - Funding research in industry
  - Funding research at universities

- **Universities**
  - Education
  - Research
  - Incubation

- **Science Park**

- **Venture Capital**
Industry

- Industrial Laboratories
  - Expenses

- Funding Research at Universities
  - Effectiveness
  - Confidentiality
  - Intellectual property
  - Recruiting vehicle
Government (Taiwan Examples)

Government Laboratories

- Industrial Technological Research Institute (ITRI) in Hsinchu
  - Founded 26 years ago in Hsinchu
  - Ten Divisions:
    - Electronics Research & Service Laboratories
    - Opto-electronics & Systems Laboratories
    - Computer & Communication Research Laboratories
    - Center for Measurement Standards
    - Center for Aviation & Space Technology
    - Mechanical Industry Research Laboratories
    - Union Chemical Laboratories
    - Materials Research Laboratories
    - Energy & Resources Laboratories
    - Center for Industrial Safety & Health Technology
    - Biomedical Engineering Center
  - Researchers and Supporting Staff: 6,000
  - Annual Budget: US$500 million
Government

- Funding research in industry
  - Research grants for industry
  - Special research grants for small business
  - Joint research grants for industry and academia
Government (Taiwan Examples)

- **Funding research at universities**
  - National Science Council
    - Established in 1959
    - Annual budget: US$500 million
  - Ministry of Education
    - Special programs for academic excellence
  - Ministry of Economic Affairs
    - Research grants for universities
Universities

- Education
- Fundamental and Applied Research
- Technology Transfer
- Consultation
- Incubation
- Start-ups
Science Park (Taiwan Example)

- Number of companies: 292
- Revenue: US$21.7 billion
  - IC: US$ 12 billion
  - PC: US$ 6.7 billion
  - Opto-electronic: US$ 1.1 billion
  - Communication: US$ 1.7 billion
  - Other: US$ 0.2 billion
- Employees: 82,778
- Provides: space, infrastructures, schools, electricity, and water, tax benefit
- International Companies
Venture Capital

- High Risk
- High Return
- Provide Expertise in Management, Finance, Marketing
- Incubation
Concluding Remarks

Education

Economy

Technology
Concluding Remarks

A Peaceful, Prosperous, and Happy World

Economics

Education

Technology