工業 4.0, 雲瑞計算, 及能源管理:挑戰與機會
IIoT, Cloud Computing, and Energy Management: Challenges and Opportunities

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Topics

- Inventions, Technological Innovation and Industrial Revolution
- Cloud Computing Technology
- IoT, Industrial IoT, and Industry 4.0
- Energy Management and Technology
- Technology Strategies: Transforming Energy, the Economy, and the World
- Your Roles: Challenges and Opportunities

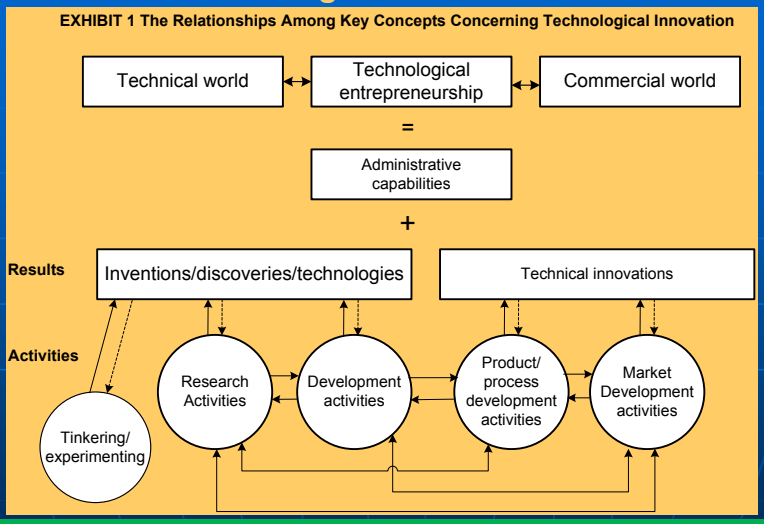
Invention, Technological Innovation and Industrial Revolution
(研究發明,創新科技,與工業革命)

Inventions/Discoveries/Technologies


Research & Development

- Inventions/Discoveries/Technologies
  - Inventions/Discoveries
    - Results of creative process
  - Successful innovations (subsequent refinement may be needed, with significant time lag, 10 years or more)
- Business (Corporation) + Government + Higher Education (產官學合作)
  - Roles of Undergraduate, Graduate Schools and Programs (faculty and students)
  - Learn (Competitiveness), Creative Problem Solving, Real-World Applications

Interrelations Among Key Concepts Concerning Technological Innovation[1]



[1]Robert A. Burgelman, Clayton M. Christensen, and Steven C. Wheelwright, *Strategic Management of Technology and Innovation, 5th edition*, McGraw-Hill, ISBN 0073381543, 2009.

Industrial Revolutions

- 1st Industrial Revolution[2]:
  - Britain - end of 18th century to mid-19th century
  - Inventions: Steam engine (James Watts), Cotton spinning machine machinery;
  - Introduction of mechanical production facilities with the help of water and stream power
  - Steam powered factory: coal, iron
  - Improved living standards

[2]The British Industrial Revolution in Global Perspective, by Robert C. Allen, 2009, Cambridge University Press, www.cambridge.org

Industrial Revolutions

- 2nd Industrial Revolution, https://en.wikipedia.org/wiki/Second_Industrial_Revolution
  - 20th century (1870 – 1914, up to the start of world war I)
  - A period of rapid industrial development
    - Primarily in U.S., Britain, and Germany
    - Advancement of manufacturing and production technology
    - Introduction of division labor and mass production with the help of electrical energy
    - Factory electrification and the production line
    - New technologies, materials, and substances: Internal combustion engine (use of petroleum), alloys and chemicals, electricity, communication technologies

Industrial Revolutions

- 3rd Industrial Revolution: 1960-2010,
  - Optimized and automated production (electronics and IT in industrial processes)
  - The digitization of manufacturing will transform the new ways goods are made – and change the politics of jobs, 2012/8/21, http://www.economist.com/node/21553017
    - Clever software, web services, novel materials, robots, new processes, 數 位 化 製 造 , 3D 列 印
  - The Third Industrial Revolution: How Lateral Power is Transforming Energy, the Economy, and the World, Jeremy Rifkin, Jan. 8, 2013

Industrial Revolutions

- 3rd Industrial Revolution: 1960-2010, optimized and automated production (electronics and IT in industrial processes)
- 4th Industrial Revolution: Industry 4.0, smart production, intelligent ICT-based (Information and Communication Technologies) machines, systems and networks

History of Technology

- Transportation Technology
  - Horse, wheeled vehicles
  - Ship, stream boat, submarines
  - railroads, steam locomotive,
  - Cars, trucks
  - Air planes, rockets
  - High-speed rails
- Energy Technology
  - Man power
  - Animal power
  - Wind, water power
  - Coal, steam power
  - Fossil fuel power
  - Nuclear

Classifications of Technology

- Energy Technology
- Business Technology
- Computer Technology
- Information Technology
- Internet Technology
- Aerospace Technology
- Biological Technology
- Material Technology
- Military Technology
- Medical Technology
- Transportation Technology
- Vehicular Technology
- Nanotechnology

- **How about:**
- HVAC Technology
- Internet of Things (物聯網)
- IIoT (Industrial Internet of Things, 工業4.0)
- Cloud Computing
- Energy Management
  - Generation side
  - Consumption side
  - SmartGrid
  - IIoT-based sensors and actuators

Histories of Disrupted Innovations and Technologies and Lessons Learned

- **The Last 40 Years Disrupted Innovations and Technologies**
  - **Electrical, Electronics, Computer, Communications & Networking, Information Technology, HVAC which Transform Life, Business, and Global Economy**
  - **科技應用: 食、衣、住、行、社交、通訊、娛樂**
- **The Only Constant is Change**

Cloud Computing Technology (雲端計算科技)

The Evolution of Computer Systems and Applications

- Computer History Museum, http://www.computerhistory.org/
  - Early computer companies
  - Analog computers
  - Mainframe computers
    - Time-sharing
    - Real-time computing
  - Supercomputers
  - Minicomputers
  - Networking
  - Personal computers
  - Mobile computing

Scalable Internet-based Computing

- Three New Computing Paradigms
  - Web 2.0 Services
  - Internet Clouds
  - Internet of Things
- Computing Paradigm Distinction
  - Centralized computing
  - Parallel computing
  - Distributed computing
  - Cloud computing

Cloud Computing Technology

- Cloud Computing:
  - Virtualized resource from data centers to form an Internet cloud, provisioning with hardware, software, storage, networks, and services for paid users to run their applications.
- Cloud Computing Service Models
  - Public cloud
  - Private cloud
  - Hybrid cloud
- Cloud Security and Trust Management

Internet of Things (IoT), Industrial IoT (IIoT), Industries 4.0 (物聯網, 工業物聯網,工業 4.0)

Internet of Things (IoT)

- IoT – What is it? (source: https://en.wikipedia.org/wiki/Internet_of_things)
  - The IoT is the network of physical devices, vehicles, buildings and other items – embedded with electronics, software, sensors, and network connectivity that enable these objects to collect and exchange data.

Internet of Things (IoT)

- The Zero Marginal Cost Society: The Internet of Things, the Collaborative Commons, and the Eclipse of Capitalism, Jeremy Rifkin, July 7, 2015, Business Weekly Publications
  - E-books and publications, communications and networking, entertainment and social networking, renewable energy, 3D printing, E-enabled higher education, cloud and mobile computing, IoT, IIoT

Internet of Things (IoT)

- What is Internet of Things - Microsoft, https://www.microsoft.com/en-us/cloud-platform/internet-of-things
  - "The Internet of Things starts with your things — the things that matter most to your business. IoT is about making your data come together in new ways. Tap into data with IoT dashboards, uncover actionable intelligence. And modernize how you do business. .."

Internet of Things (IoT)

- Cisco IoT System, http://www.cisco.com/c/en/us/solutions/internet-of-things/overview.html
  - "The IoT links smart objects to the Internet. It can enable and exchange of data never available before .. Cisco estimates the IoT will consist of 50 billion devices connected to the Internet by 2020. Gain deeper insight with analytics .. To enhance productivity, create new business models, and generate new revenue streams."

研華 IoT 智慧整合系統

- Embedded IoT Solutions, http://www.advantech.tw/products/embedded-iot-solutions/sub_7f854079-4f60-47c7-9bc6-07cc21c0e740
  - Embedded IoT Gateway
  - Wireless Sensor Network
  - Wireless Modules
- Advantech IoT Mart, http://www.iotmart.com.tw/

中都智慧城:宜居樂業的新星[3]

- 智慧生活城市的發展方向
- 智慧生活城市的主要內涵
  - 智慧市政整合指揮中心, 智慧交通, 智慧警政
  - 智慧市政服務及參與系統
  - 智慧防災與救援
  - 智慧教育
  - 智慧能源利用與管理

[3]城市行動派 – City Visionary in Action , 2nd Edition, 林佳龍著 , March 2015, 遠景出版事業有限公司

IoT Technology – Applications and Business Opportunities

- Manufacturing (IIoT)
- Vehicle fleets
- Retials
- Smart Cities, Public Utility Monitoring (water, electricity), Smart building, Smart Home
- IoT Healthcare Solutions (remote patient monitoring)
- Smart Hospitals

IoT Application Case Study Questions

- Consider a Home Appliance company which sells dryers, washers, refrigerators, ovens, HVAC (thermostat), home security camera, etc, for the residential applications. As a technology manager, you are asked by the VP of Technology to conduct a research study which will explore IoT technology and opportunities to unlock new business values and increase competitive advantages. The initial tasks are involving (a) understanding the IoT technology, (b) IoT devices and platforms and providers, (c) IoT connectivity, (d) IoT development tools, (e) IoT security and privacy challenges, (f) IoT cloud services, etc.

Industrial 4.0

- Industrial 4.0 – What is it?
  - Reference: http://www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Brochures/Industries/industrie4.0-smart-manufacturing-for-the-future-en.pdf
- Industry 4.0 connects embedded system production technologies and smart production processes to pave the way to a new technological age
- Enterprise resource planning (ERP), Manufacturing Execution System (MES), Process Control System (PCS)

- Industries 4.0, http://www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Brochures/Industries/industrie4.0-smart-manufacturing-for-the-future-en.pdf

- Smart Manufacturing for the Future, http://www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Brochures/Industries/industrie4.0-smart-manufacturing-for-the-future-en.pdf

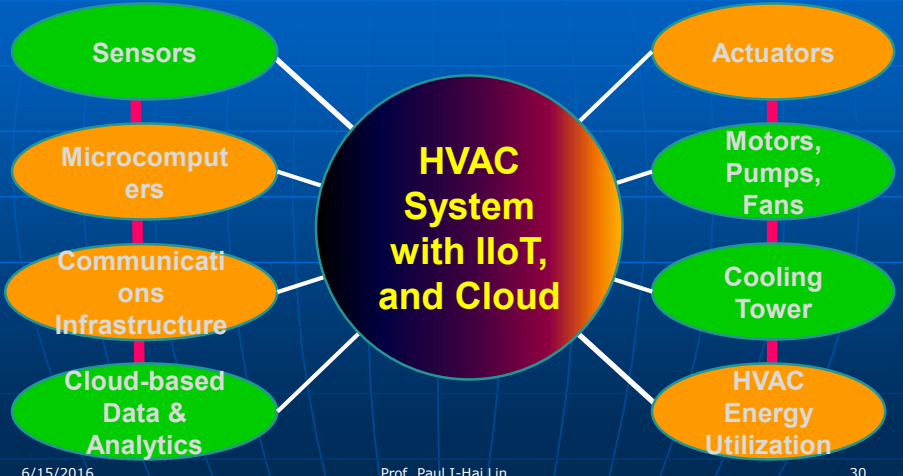
Energy Management and Technology
(能源管理與科技)

Residential and Commercial HVAC Systems

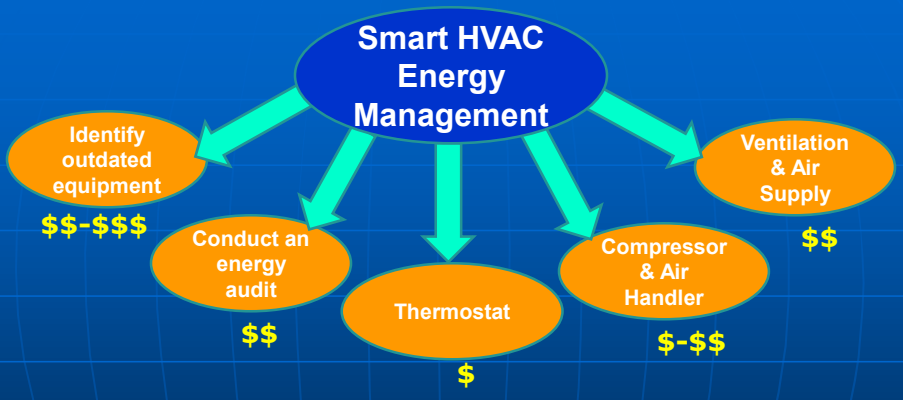
- Cloud Computing & IT Technology
- Smart Meters
- Home automation: sensors, consumer electronics, appliances, HVAC, energy management
- Monitoring and Control with Traditional Building Management System (BMS) or Building Automation Systems (BAS)
- Smart HVAC using IIoT and Cloud
  - Internet connected systems
  - Broadband, sensors, smartphones
  - Cost and usage of data

Energy Management using IoT and Cloud Technologies for Commercial HVAC

- Smart HVAC System: Collect data from different sources and act upon; Energy Monitoring and Control



Reference: http://www.link-labs.com/smart-hvac/



Smart HVAC

- Merge equipment and control
- Machine talks to other machines
- Sense operational data, and Move operational data
- Learn where and how much heat or air to bring to each section of the building
- Monitor external sources and internal functionalities: Efficiency analysis and optimum efficiency maintenance
- Automatically configuration to use less power

Smart HVAC Examples

- Smart HVAC: Daikin Transforms Industry with IoT Solutions, (4:14 min video), http://www.intel.com/content/www/us/en/internet-of-things/customer-stories/daikin-applied-transforms-hvac-systems.html
- IoT Transforms Commercial Buildings: ClimateMaster iGate, http://www.achrnews.com/articles/128324-iot-transforms-commercial-buildings
- Consulting Specified Engineer

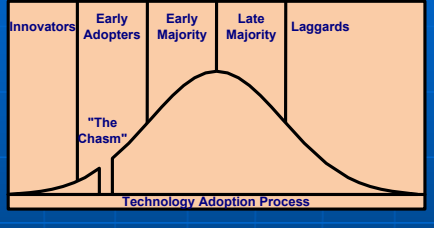
Technology R&D and Commercialization Strategies: Transforming Energy, the Economy, and the World
(科技研發與商業化 策略)

Technology R&D and Commercialization

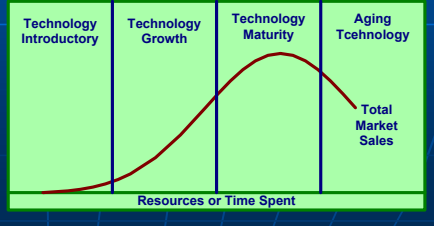
- Technology Development Processes
  - Identification of a specific need
  - Assessment
  - Strategy, Funding, Plan, etc
  - Design
  - Prototyping
  - Transfer (Intellectual property)
- Commercialization
  - Production
  - Marketing
  - Sales
  - Distribution
  - Customer support
  - Maintenance
- User/customer/consumer

Evolutionary Forces Shaping Technology Strategy: Technology Evolution

- Technology Adoption Cycle



- Technology S Curve



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Examples of Disruptive Technology: Internet Technology

- Computer-computer communications
- Collaboration, resource sharing
- Information sharing/publishing
- E-learning and education
- Advertisement
- Business automation
- Communications
- E-business/E-commerce
- Online Services, Social networking
- Cloud-based Computing
- Internet of Things
- Energy Network and Management (Smart power grid)

Technology Challenges and Opportunities

- Cloud Computing & IT Technology
- Mobile Apps
- Environmental and Infrastructure Monitoring
- Smart Sensor Networks
- Energy Harvesting Technologies (Wasted heat & Thermoelectric generator; Solar power & Thermoelectric cooling)
- SmartGrid Technology
- Smart Software Programs and Apps
- Cloud Computing
- Internet of Things
- System Integration Technology for Energy Management (Efficiency Improvement): IIoT, Cloud, and Energy Management
- Smart HVAC, Smart Buildings, Smart Cities

Your Roles: Challenges and Opportunities
(自我角色: 挑戰與機會)

Summary and Conclusion

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