台北科技大學電資學院專題演講

2018 新科技及創新應用趨勢圓桌會談: 能採用系統化思考, 巧妙的策略整合新科技去解決新世代問題的新科技人-你,必是未來贏家

March 14, 2018

Purdue University Fort Wayne

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2018 New Tech and Innovation Trends Roundtable: Adopting a systems thinking approach, integrating new technologies and strategies to solve next generation problem will be Winners.

March 14, 2018

An Invited Talk at
College of Electrical Engineering & Computer Science
National Taipei University of Technology

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演講大綱 (Topics of Discussion)

- Terms and Definitions: Science, Engineering, Technology, and Innovation
- Importance of Technology and Innovation
- Technology and Innovation Activities
- Representative Technologies in Firm's Value Chain
- Integrating Key Technologies and Strategies
- Examples of Disrupted Technologies
- IoT, IIoT, Industrial 4.0
- Artificial Intelligence and Robots
- Other Emerging and New Disrupting Technologies

Terms and Definitions (相關名詞及定義)

- Science (科學)
  - (knowledge from) the careful study of the structure and behavior of the physical world, especially by watching, measuring, and doing experiments, and the development of theories to describe the results of these activities, https://dictionary.cambridge.org/dictionary/english/science

Terms and Definitions (相關名詞及定義)

- Engineering (工程)
  - The work of an engineer, or the study of this work, https://dictionary.cambridge.org/dictionary/english/engineering
  - The art or science of making practical application of the knowledge of sciences …, http://www.dictionary.com/browse/engineering
  - The application of science and mathematics by which the properties of matter and the sources of energy in nature are made useful to people, https://www.merriam-webster.com/dictionary/engineering

Terms and Definitions (相關名詞及定義)

- Technology (科技, 應用技術, 工業技術) - 字典解釋
  - The application of scientific knowledge for practical purposes, especially in industry, https://en.oxforddictionaries.com/definition/technology
  - (the study and knowledge of) the practical, especially industrial, use of scientific discoveries, https://dictionary.cambridge.org/dictionary/english/technology

Terms and Definitions (相關名詞及定義)

- Innovation (改革, 創新, 新觀念, 新發明, 新設施)
  - https://www.merriam-webster.com/dictionary/innovation
    - 1: the introduction of something new; 2: a new idea, method, or device: novelty
  - https://dictionary.cambridge.org/dictionary/english/innovation, (the use of) a new idea or method
  - http://www.businessdictionary.com/definition/innovation.html
    - The process of translating an idea or invention into a good or service that create value or for which customers will pay. To be called an innovation, an idea must be replicable at an economic cost and must satisfy a specific need. …

Technology (科技, 應用技術, 工業技術)

- Technology: theoretical and practical knowledge, skills, and artifacts that
  - Can be used to develop products and services, production and delivery systems etc.
  - Can be embodies in people, materials, cognitive and physical processes, plant, equipment, and tools
- Technologies: usually the outcome of development activities to put inventions and discoveries to practical use

History of Technology

- Technology in Archaeology
  - Material technologies (stone tools, wood, pottery, copper, bronze, iron (steel))
  - Agriculture technologies
  - Information technologies (cave art, Venus figures, writing)
  - Energy technologies (fire, irrigation, sailing ships, wheeled vehicles)

History of Technology

- **Transportation Technology**
  - Horse, wheeled vehicles
  - Ship, stream boat, submarines
  - railroads, steam locomotive, high-speed rails
  - Cars, trucks
  - Air planes, rocket
- **Energy Technology**
  - Man power
  - Animal power
  - Wind power
  - Solar power
  - Coal, steam power
  - Fossil fuel power

History of Technology

- **Technology – Military Conflicts**
  - Ancient warfare (weapons and armor; clubs, spears, knifes, bow and arrows)
  - Medieval warfare (military tactics, cavalry-based forces)
  - Gun power warfare (first developed in Song Dynasty, 960 – 1279, China)
  - Industrial warfare (mass-conscripted armies; rapid transportation – railroads, sea, and air; telegraph and wireless communications)
  - Modern warfare (variety of tools and methods available to modern battlefield commanders)

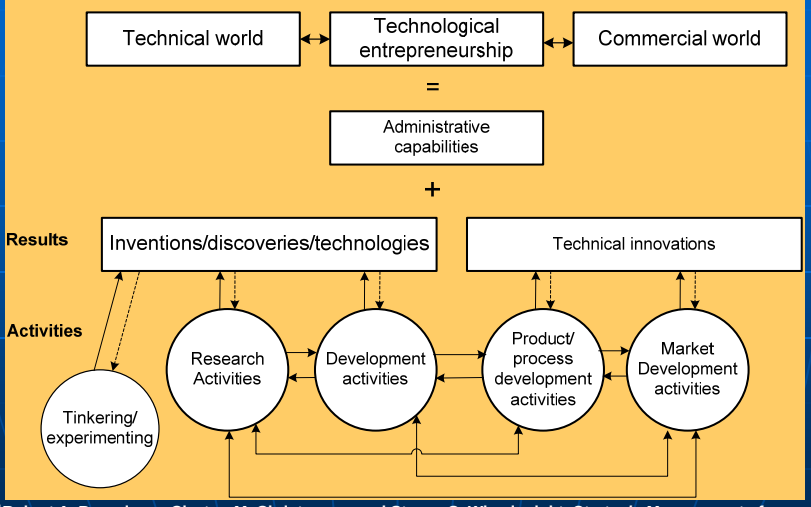
Classifications of Technology

Specific Applications

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

Interrelations Among Key Concepts Concerning Technological Innovation[1]

EXHIBIT 1 The Relationships Among Key Concepts Concerning Technological Innovation



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

公司價值鏈及需用之代表性科技
Representative Technologies in a Firm's Value Chain

Exhibit 6 Representative Technologies in a Firm's Value Chain

Inbound logistics	Operations	Outbound logistics	Marketing sales	Services
Transportation technology Material handling technology Storage and preservation technology Communication system technology Testing technology Information system technology	Basic product technology Material technology Machine tool technology Material handling technology Packaging technology Maintenance methods Testing technology Building design operation technology Information system technology	Transportation technology Material handling technology Packaging technology Communication system technology Information system technology	Media technology Audio and video recording technology Communication system technology Information system technology	Diagnostic and testing technology Communication system technology Information system technology

Source: M.E. Porter, Competitive Advantage: Creating and Sustaining Superior Performance, New York: Free Press 1985

科技及創新之重要性
Importance of Technology & Innovation to Companies

- Developing internal capability
- Achieving business growth goals and improving bottom line results
- Looking to the future and maintaining competitive advantages
- Increasing productivity and efficiency
- Increasing company value (more attractive)
- Increasing ROI to shareholders

是誰負責公司科技及策略管理?

- Who is responsible for strategic management of technology & innovation of a company, organization, firm, etc.?
  - CEO (Chief Executive Officer) -總裁
  - Vice President of Technology-科技副總裁
  - Director/Manager of Technology-科技部主任/經理
  - Chief Research Officer/Manager - 研究總監/經理
  - CTO (Chief Technology Officer) -科技長,科技總監
  - CIO (Chief Information Officer)-資訊總監
  - CSO (Chief Strategy Officer)- 首席策略長
  - CRO (Chief Risk Officer)-首席總監
  - Chief Visionary Officer- 前瞻性總監

主要負責及管理項目

Who is responsible for strategic management of technology & innovation of a company, organization, firm, etc.?

- Top-Level Administrator/Manager's Responsibilities are to (1) Acquire, develop, and allocate an organization's resources; (2) Develop and exploit the firm's capability for innovation

Other management activities:

- Tech staffs, support groups, subcontractors, vendors, partners, customers, government agencies

今日高科技公司之特性與挑戰

- Characteristics and Challenges of Today's Technology-Based Business
  - High task complexities, risks, and uncertainties
  - Fast-changing markets, technology, regulations
  - Intense competition, open global markets
  - Resource constraint, tough performance requirements
  - Tight, end-date-driven schedules

The 10 Biggest R&D Spenders Worldwide in 2013

http://fortune.com/2014/11/17/top-10-research-development/

1. Volkswagen, www.vw.com (German carmaker): $13.5 billion, 5.2% of revenue
2. Samsung, www.Samsung.com (South Korean conglomerate): $13.4 billion, 5.2% of revenue
3. Intel, www.intel.com (Santa Clara, CA-based chip manufacturer): $10.6 billion, 20.1% of revenue
4. Microsoft, www.Microsoft.com (Seattle, WA): $10.4 billion, 13.4% of revenue
5. Roche, www.roche.com (Swiss biopharmaceutical company): $10 billion,19% of revenue

The 10 Biggest R&D Spenders Worldwide - 2013

6. Novartis AG, www.novartis.com (Pharmaceuticals, eye care, and generics): $9.9 billion, 16.8% of revenue
7. Toyota, www.Toyota.com (Japanese automaker): $9.1 billion, 3.5% of revenue
8. Johnson & Johnson, www.jnj.com (American health care company): $8.2 billion, 11.5% of revenue
9. Google, www.google.com (Mountain View, CA-based Internet company): $8 billion, 13.2% revenue
10. MERCK, www.merck.com (NJ –based pharmaceutical company): $7.5 billion, 17% of revenue

Top 10 Companies with Highest R&D Spending in 2017

(in billion U.S. dollars)

- Amazon – $16.1B
- Aplhabet (Parent company of Google) – $12.9B
- Intel – $12.7B
- Samsung – $12.7B
- Volkswagon - $12.1B
- Microsoft – $12B
- Roche – $11.4B
- Merck - $10.1B
- Apple – $10B
- Novatis - $9.6B
- Toyota - $9.3B

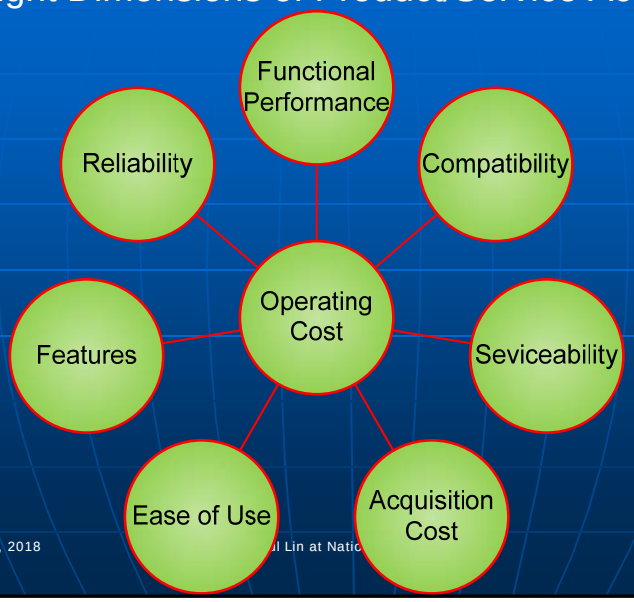
source -https://www.statista.com/statistics/265645/ranking-of-the-20-companies-with-the-highest-spending-on-research-and-development/

整合公司各種關鍵科技及策略之管理方式

- **Integrating Key Technologies and Strategy**
  - Perspectives on Strategy
  - Connecting Technology and Strategy
  - Technology and the Value Chain
  - Technology Evolution and Forecasting

影響實質及服務產品接受度之八個因數

- Eight Dimensions of Product/Service Acceptability



科技之進化及預估
Technology Evolution and Forecasting[1]

- Technology Lifecycle and Competitive Advantages
  - Affecting firm's competitive position
  - Difficult to respond to such changes
- Integrating Technology & Strategy
  - Should be a dynamic process
  - Should understand the links between Stages in Technology Life Cycle & the Potential for Competitive Advantages

依市場區隔去做科技歸類
Profiling Technology by Market Segments

- What have the rates of change been in the past? And can your project a continuation of those rates into the future?
- How fast must one company move to gain ground on the others?

Technology Life Cycle and Competitive Advantages[1]

Stages in Technology Life Cycle	Importance of Technologies for Competitive Advantages
I. Emerging technologies	Have not yet demonstrated potential for changing the basis of competition.
II. Pacing technologies	Have demonstrated their potential for changing the basis of competition.
III. Key technologies	Are embedded in and enable product/process.
	Have major impact on value-added stream (cost, performance, quality).
	Allow proprietary/patented positions
IV. Base technologies	Have minor impact on value-added stream; common to all competitors; commodity

Examples of Disruptive Technology

- Personal Computer (and clones) Disrupted Main Frame and Mini Computers
  - IBM, DEC (Digital Equipment Corp), Apple, HP, Dell, Taiwan's PC manufacturers

PDP 11

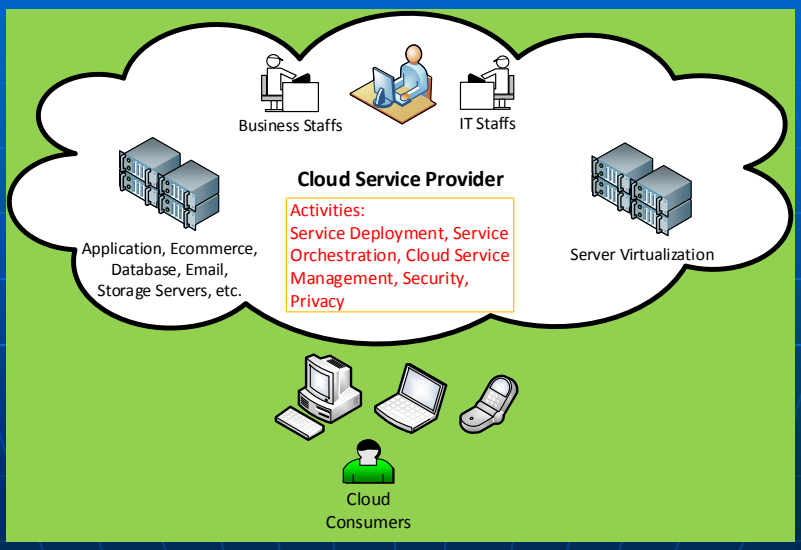
IBM PC

Cloud Computing
Systems and Enabling Technologies

The Evolution of Computer Systems and Applications

- Client-Server Computing
- Distributed Computing
- Virtualization and data centers
- Utility Computing
- Grid Computing
- Internet computing
- Web services
- Service-Oriented Computing (SOA)
- Mobile Computing
- Cloud Computing

Cloud Computing Services



Examples of Disruptive Technology

- Smart Phones Disrupted PCs

Emerging and New Disruptive Technology

- Internet of Things (IoT), Industrial Internet of Things (IIoT)
- 5G – 5th Generation Mobile Networks
- Artificial Intelligence
- Robotics
- 3-D Printing
- Medical Technology
- High Speed Travel Technology (Hyperloop)
- Blockchain Technology
- Autonomous Smart Vehicles
- Advanced Virtual Reality
- Renewable Energy (fossil fuels, biomass, renewable, nuclear)

References: https://richtopia.com/emerging-technologies/11-disruptive-technology-examples

IoT, IIoT, and Industrial 4.0

- **Internet of Things (IoT)**
- **Industrial Internet of Things (IIoT)**
- **Industrial 4.0**

IoT, IIoT, and Industrial 4.0: Subsystems

- **Internet of Things (IoT)/Industrial Internet of Things (IIoT)/Industrial 4.0**
  - Processors/Microcontrollers with Power management
  - Sensors, Analog signal sensing and processing
  - Actuators
  - Wireless connectivity and management technologies
  - Security
  - Messaging protocols/subsystems
  - Gateways
  - Public and private cloud services
  - IoT database and data warehouse
  - Big data and data analytics

IoT and IIoT Connectivity Technologies

- Low Energy Bluetooth
- 802.15.4, Zigbee
- Bridge/Gateway
- LAN/WiFi to WAN
- Cellular Networks
  - 3G, 4G, LTE
  - LTE-M (LTE Machine)
  - LTE-NB (LTE-Narrow Band)
  - Extended coverage-GSM-IoT networks, https://www.gsma.com/iot/extended-coverage-gsm-internet-of-things-ec-gsm-iot/
  - Cellular 5G networks, https://www.gsma.com/publicpolicy/5g-internet-things-iot-wearable-devices

IoT and IIoT Protocols

- **Application Layer (data protocols):**
  - **MQTT** (Message Queuing Telemetry Transport) – publish/subscribe model uses TCP/IP
  - **CoAP** (Constrained Application Protocol) – request/response model uses UDP like HTTP
  - **AMQP** (Advanced Message Queuing Protocol) – publish/subscribe model and point-to-point
- **Transport**
  - UDP and TCP
- **Networking**
  - IPv6 and Ipv4
- **Data Link**
  - Ethernet, WiFi, Bluetooth Low Energy, EC-GSM-IoT, ELTE-M, LTE-NB

IoT and IIoT Protocols

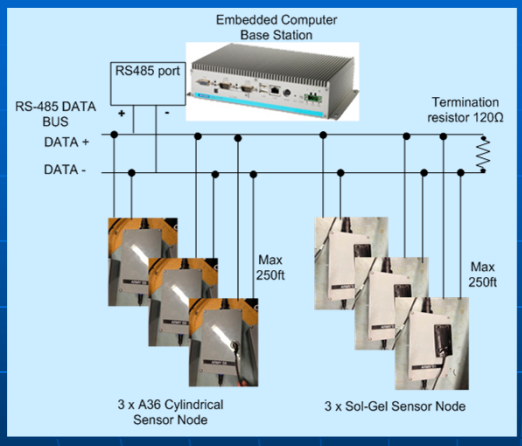
- **Data Link**
  - Ethernet, WiFi, Bluetooth Low Energy
  - GSM
  - EC-GSM-IoT
  - LTE-M (Long-Term Evolution for Machine)
    - https://www.gsma.com/iot/long-term-evolution-machine-type-communication-lte-mtc-cat-m1/
    - https://www.business.att.com/solutions/Service/internet-of-things/networks/lte-m/
    - https://www.sierrawireless.com/iot-blog/iot-blog/2018/01/lte-m-and-nb-iot-what-to-know-before-you-start-development/

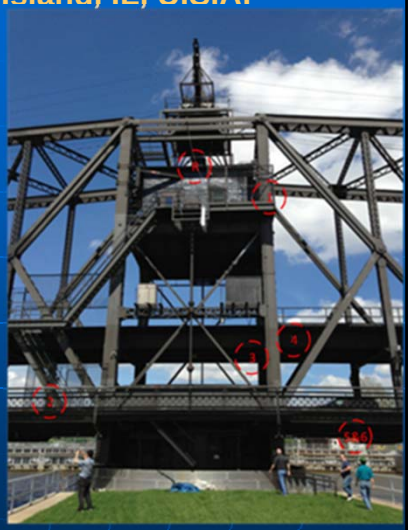
IoT/IIoT Applications

- Water Quality Monitoring
- Bridge Health Monitoring
- Smart Cities
- Smart Agriculture
- Smart Medical/Healthcare
- Smart Transportation System (vehicles)
- Connected Factories

Bridge Health Monitoring[2]

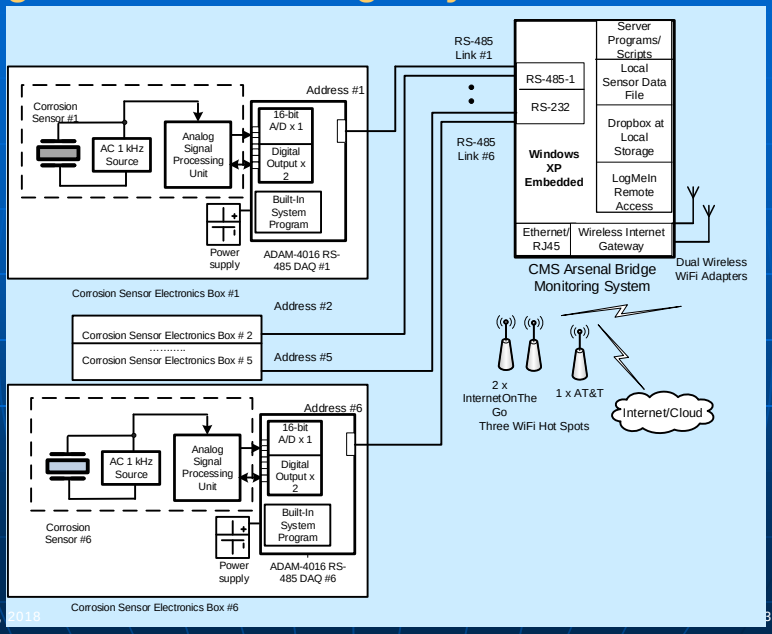
U.S. Army Bridge at Rock Island, IL, U.S.A.



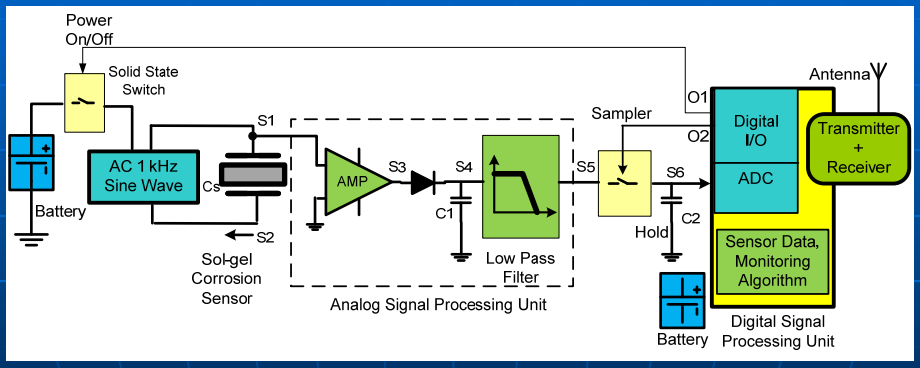


[2]Max Yen, Paul I. Lin, Dong Chen,
http://www.etcs.ipfw.edu/~lin/CorrosionSensorSys/HomeCorrosionSensorProject.html

Bridge Health Monitoring – System Architecture



Bridge Health Monitoring – Sensor Nodes



Artificial Intelligence and Machine Learning

- Artificial Intelligence:
  - the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as **visual perception**, **speech recognition**, **decision making** and **translation between languages**. (https://en.oxforddictionaries.com/definition/artificial_intelligence)
  - Merriam-Webster: (1) a branch of computer science dealing with the simulation of intelligent behavior in computers; (2) the ability of a machine to imitate intelligent human behavior

Artificial Intelligence and Robots

- **AI Example in Use Today**
  - **Commercial Flights: use of AI autopilot**
  - **Apple Siri**
  - **Google Maps: AI powered**
  - **Facebook: when you upload photos, the service automatically highlights faces and suggests friends to tag**
  - **Amazon Alexa**
  - **Tesla: Self-driving features**
  - **Online shopping: recommendations**
  - **Sophia, ASIMO, QRIO, Pepper, Actroid: AI Robots**

Emerging and New Disruptive Technology

- 3-D Printing
- Medical Technology
- High Speed Travel Technology (Hyperloop)
- Blockchain Technology
- Autonomous Smart Vehicles
- Advanced Virtual Reality
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Conclusion

Thank you!