2013年國科會工業工程與管理學門成果發表會

IE與綠能/永續發展論壇

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11/9/2013

東海大學

大 綱

1. 21世紀新經濟系統
2. 東海大學＆工學院 GREEnS 計畫
3. 未來企業 (EoF) 與未來工廠 (FoF)
4. IE 與 永續社會、永續環境、永續經濟(含生產)
5.

1. 21世紀新經濟系統

工業革命演進流程

第一次工業革命

(18 世紀)機器取代手工

第二次工業革命

1. 開創了「電力、內然發動機、新材料與物質、電報與無線電通信技術」的時代

2. **燃油蒸汽渦輪機和內燃驅動的**船、飛機、汽車、4C消費品…

3. **破壞大自然**

第三次工業革命

1.「**數位科技、材料科學、綠色能源**」**大突破**

2. **新經濟系統**

3. **將把每一棟建築物變成微型發電站，可以生產出自有能源**

4. **親近與維護大自然、善用永續資源與能源**

Source: Refkin, J., The Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World. Palgrave Macmillan, 2011.

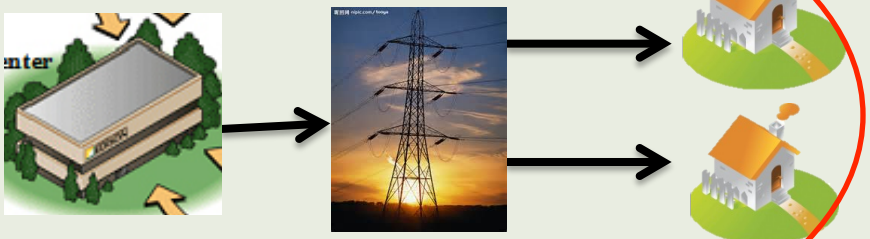
新經濟系統的重要支柱

1.從碳化石
→再生能源

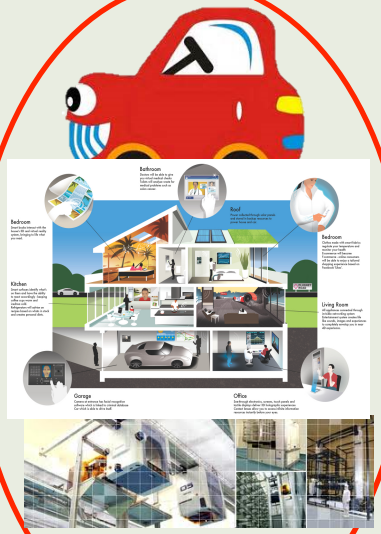
2.將各區、各國、個城的建築物轉化為微型發電廠

3 再生能源儲存技術

4.智慧電網（能源共用網）



5. 綠色交通
6. 未來生活
7. 未來企業
8. 未來工廠
(綠色製造：3DP)
9...
...



Source: Refkin, J., The Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World. Palgrave Macmillan, 2011.

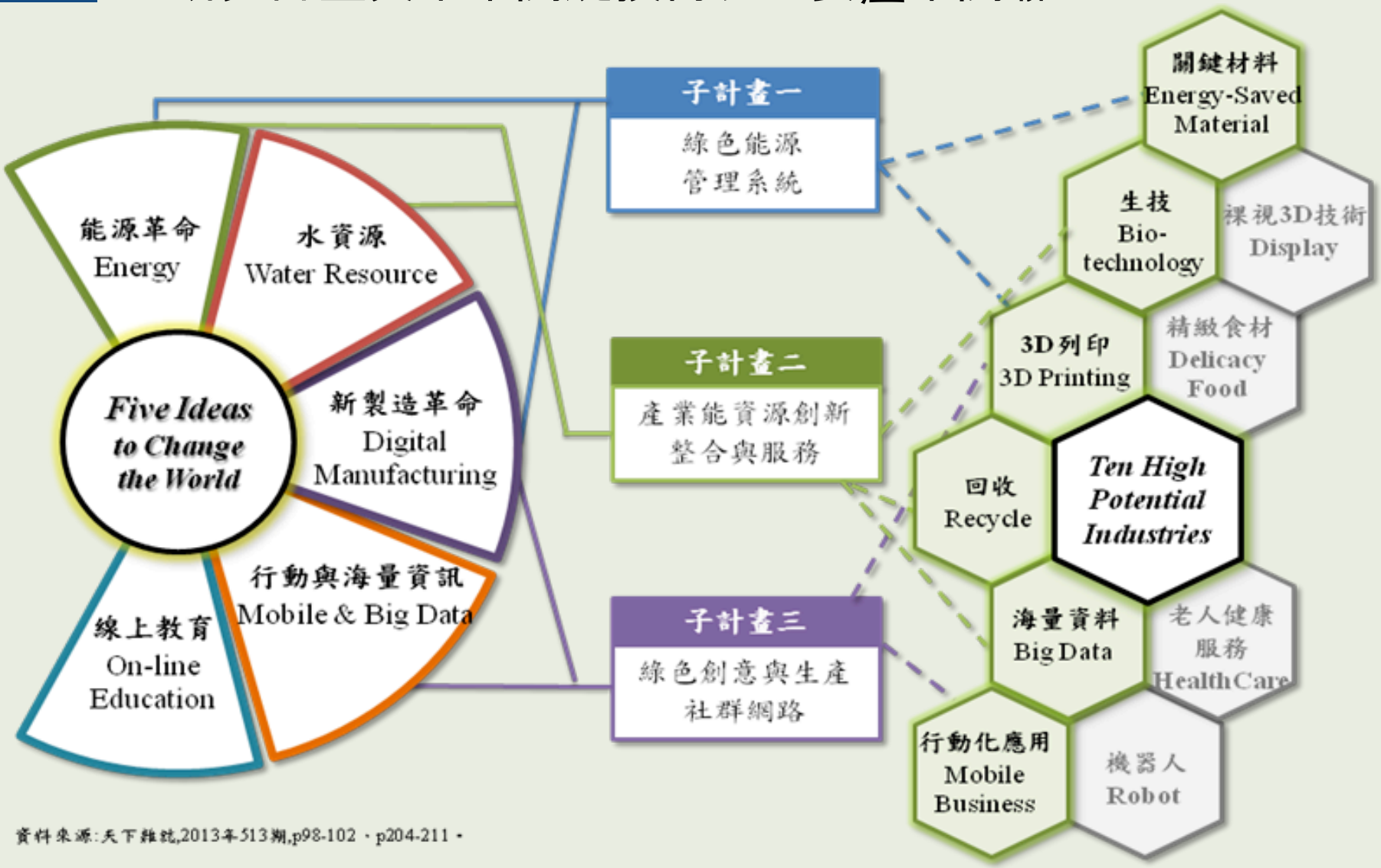
東海大學 TUNGHAI UNIVERSITY
GREEnS
全球環境暨永續社會發展計畫
Global Research & Education on Environment and Society

2. 東海大學：綠色博雅大學＆工學院 GREEnS 計畫

東海大學

東海綠能開發與管理研究中心

研究計畫與未來關鍵技術及重要產業關聯



資料來源:天下雜誌,2013年513期,p98-102、p204-211。

TGEI東海綠能開發與管理研究中心
第一年各子計畫重點及關聯性

產能+ 儲能

子計畫一：碳矽能源(太陽能電池)產製與儲存

節能+ 減碳

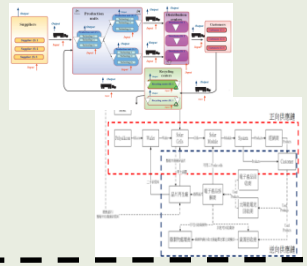
子計畫二：碳資產管理與綠色供應鏈管理(永續經營)

策略與設計

GSCM績效評估

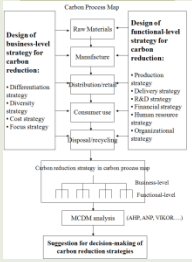
KPI

GSCM設計

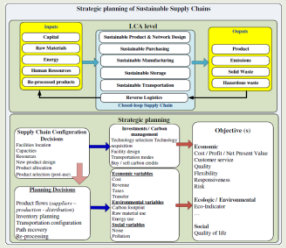


GSCM策略建議

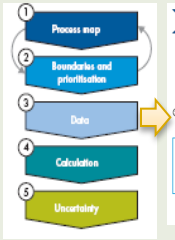
減碳策略

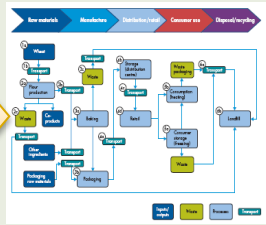


LCA方法論



碳揭露模式(Carbon Process Map)





規劃與分析

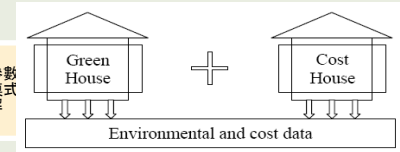
製程最佳化

田口品質工程/ Data Mining

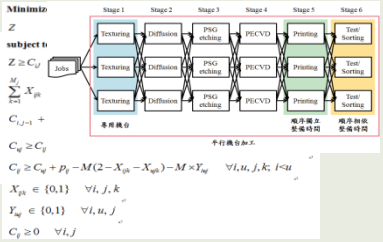
製程參數優化模式建立

製程參數優化模式求解

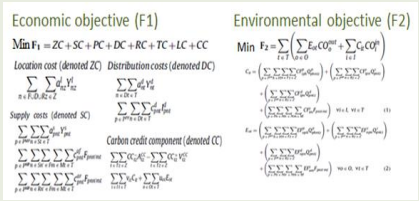
綠色產品生命週期分析



單廠區生產規劃最佳化



GSCM最佳化模式



執行技術

碳計算技術與方法

實地觀測技術與估計方法

Carbon footprint of a given activity =
Activity data (mass/volume/kWh/km) ×
Emission factor (CO2e per unit)

利用既有資料，合理推估各式活動的碳排放量

碳排放量之產業Benchmark

✓產業碳盤查平台
✓產業碳排放標竿值建立

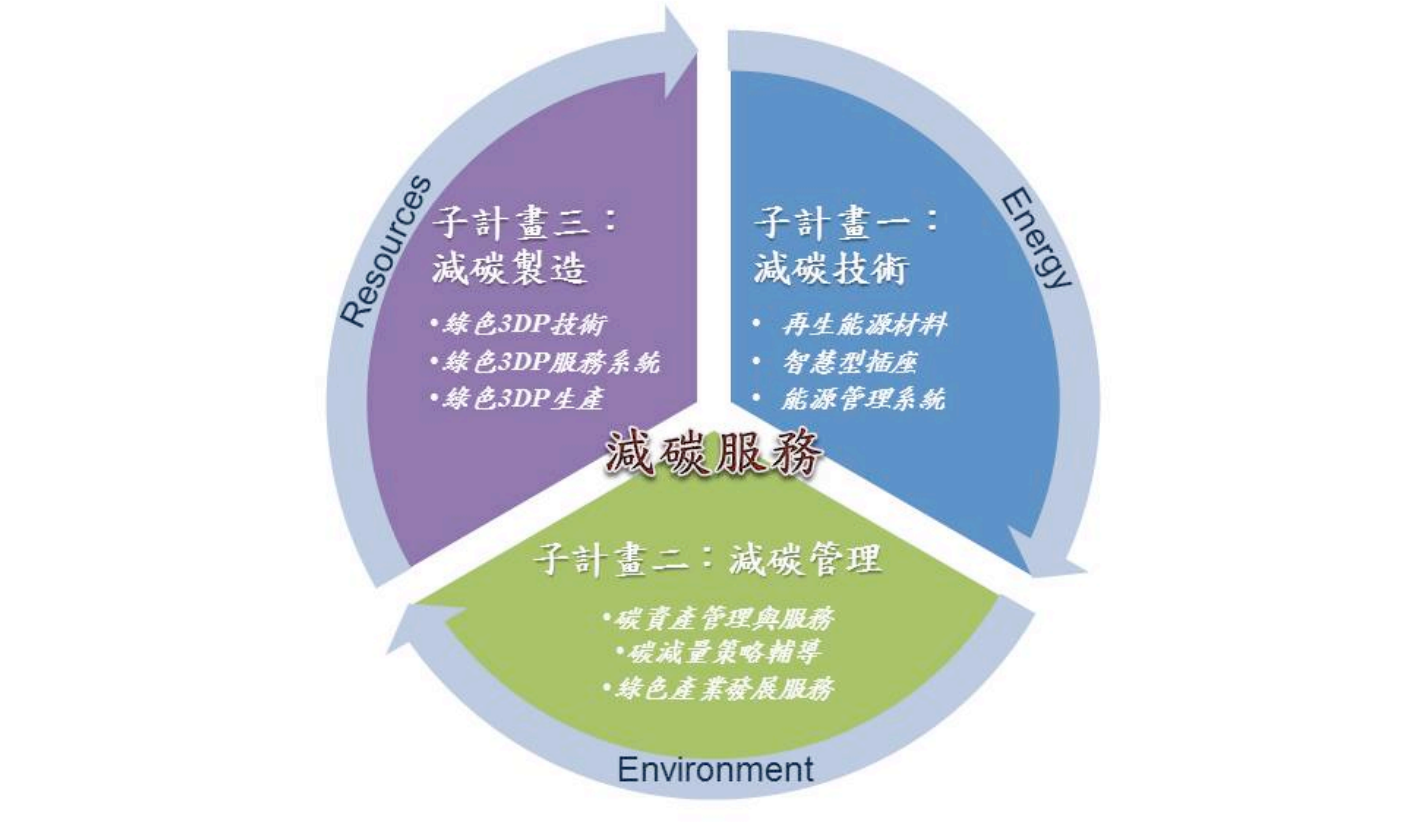
✓碳匯方法學建立
✓碳減量及碳捕集技術平台
✓清潔生產

產業「碳中和」策略規劃

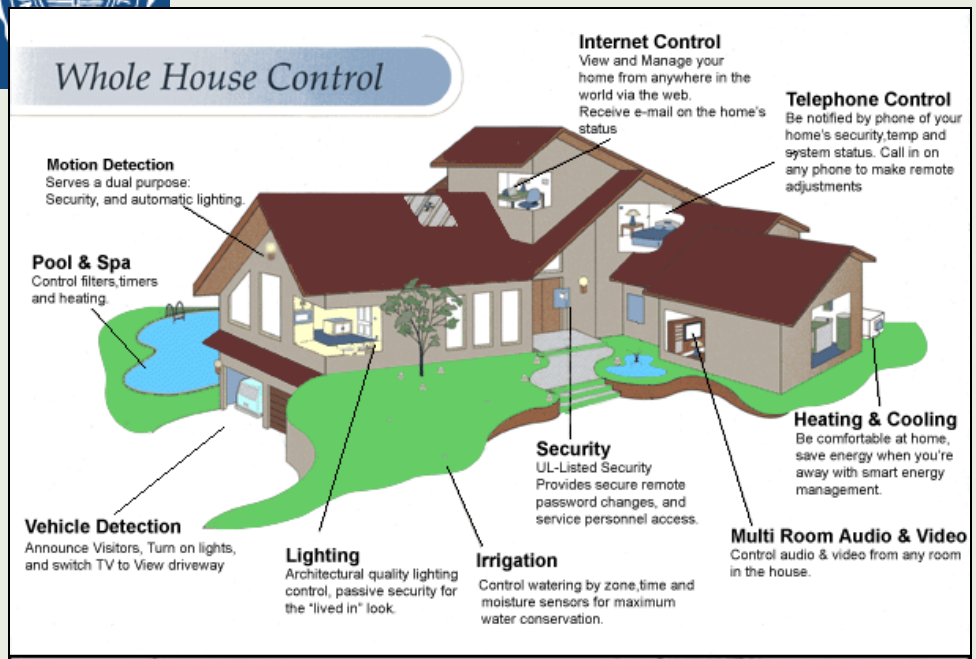
子計畫四：簡約計算與綠色ERP

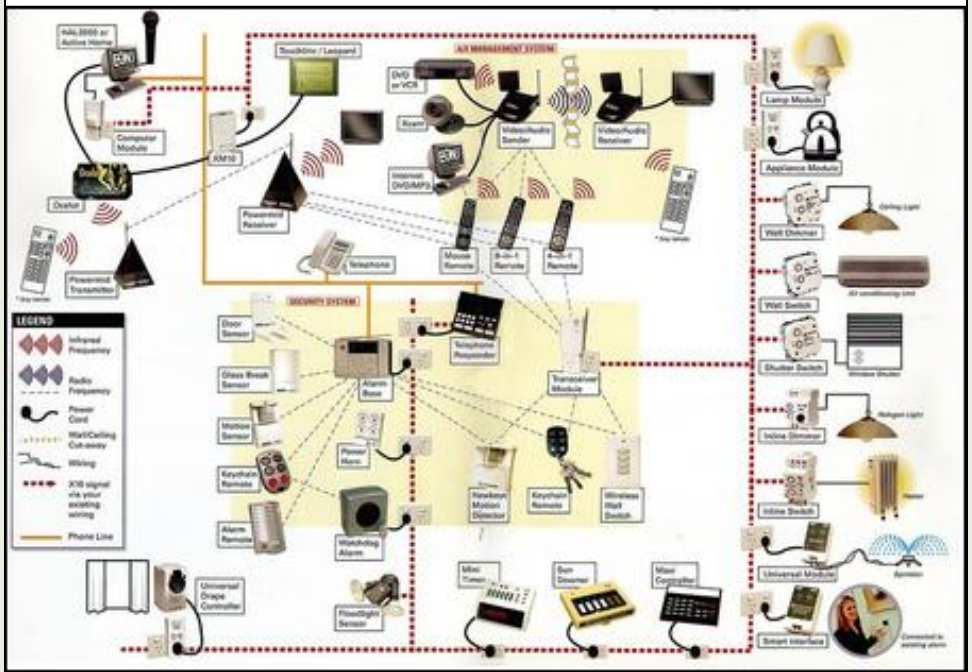
東海綠能開發與管理研究中心

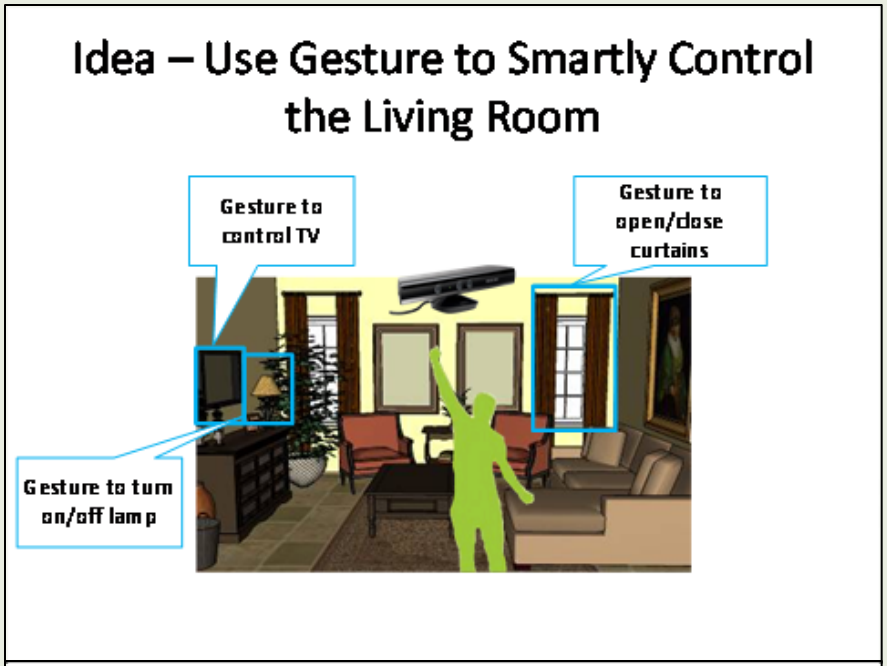
第二年計劃:「次世代減碳技術與碳資產管理」

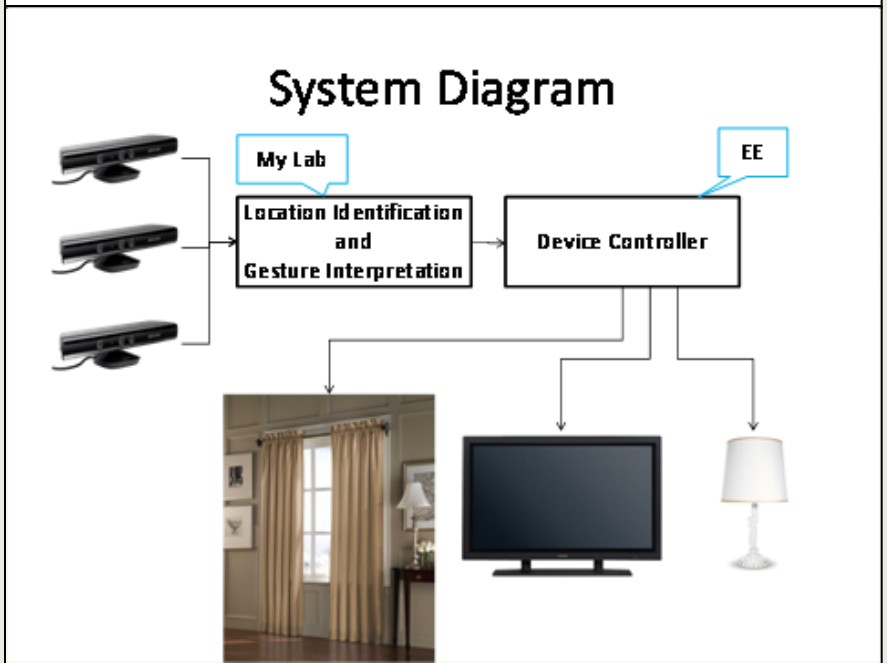


智能生活 (Smart Living) 環境&架構示意圖









3. 未來企業 (EoF) 與未來工廠 (FoF)

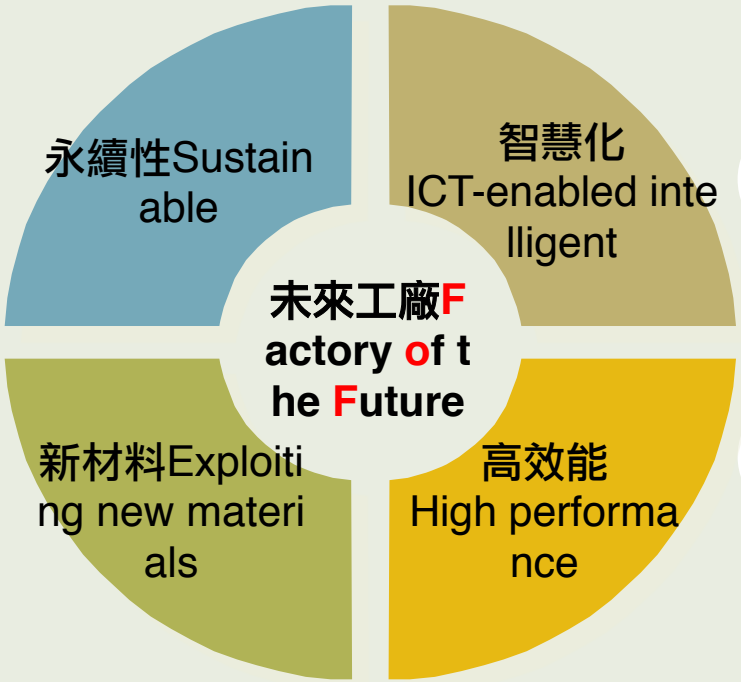
企業資訊應用系統的未來趨勢

The Future of Enterprise Applications and ERP

1. SaaS: 雲端部署模式改變了應用經濟性
   Software-as-a-service (SaaS): Cloud deployment models change application economics
2. 可攜式技術加速了企業流程的運作效益
   Mobile: Mobile technology accelerates business processes
3. 企業流程管理:企業藉由嵌入式建模工具, 導入符合特性的應用系統且流程更具彈性
   Business process management (BPM): Business process flexibility evolves via embedded modeling tools
4. 更加結合使用者經驗、思維與互動性
   Usability: Application user experiences advance to the next level
5. 企業可透過雲端服務平台，使得應用系統更具延展性（既有系統+新功能）
   Platform-as-a-service (PaaS): Extensibility improves via PaaS
6. 彈性應用平台(EAP): 提供企業自動且彈性地處理與分析大量的交易資料與市場資訊
   Elastic computing: Elastic computing platforms scale transactions and analytics
7. 有效運用社群網絡於應用系統與企業流程
   Social networks : Collaboration comes to applications in context via social tools

Forrester: Hamerman, P. D., Seven trends to shape the future of enterprise applications and ERP, July 20, 2011.

FoF的目標：具競爭優勢的永續性製造
Competitive and Sustainable Manufacturing (CSM)



轉型 *transformation* of enterprises due to the needs of customization and sustainability, thus increasing the chances of success and global leadership.

技術 boosting the level of *technologies for products and processes* towards global leadership,

智能 making Europe a global leader as both the producer and operator of factories and factory equipment (lead markets) with *intelligent products, processes* and *new business models*.

先機 activating the potential of *novel enabling technologies* and *developing solutions* for emerging markets.

達成FoF-CSM的R&D挑戰 (1)

a) 成本效率：*Cost efficiency*, with extensive adoption of standards in production machinery, equipment and controls and massive use of the *lean approach*（*精實方法*）;
b) 最適當的消耗資源：Optimized consumption of resources through the use of energy and material efficient processes and machinery, renewable power sources, and smart energy management with extensive recovery of heat and dissipated energy;
c) 善用ICT縮短上市時間： *Short Time to Market* (from the concept to new products on the market), enabled *by ICT applications*, which will increasingly be relevant in manufacturing industries;
d) 專注於高附加價值元件/產品：Increased focus on high added value components/goods through the use of enabling processing technologies and enhanced materials;
e) 模組化的生產系統：Adaptability/re-configurability through *a modular approach* in production systems, in order to maximise autonomy and interaction capability of machinery and continuous re-use of existing infrastructures;

Source: Ad-hoc Industrial Advisory Group, “Factories of the Future PPP, Strategic Multi-annual Roadmap”, 20 January 2010

達成CSM的R&D挑戰 (2)

f) 高品質：Higher and more stable product quality through increased process robustness and accuracy, while ensuring an easy process maintainability;

g) 安全且人性化的高生產力：Higher productivity under enhanced safety and ergonomics conditions, through an *upstream integration* in factory design of workplace optimisation for human well-being;

h) 全球合作的生產/供應鏈體系：Increased reusability of production systems towards *global interoperable factories*, which are able to provide services and develop products anytime and anywhere, independently of the technologies, culture or language in use in the different production sites;

i) 新製造技術：New products, requiring new manufacturing technologies adapted to new features.

Manufacturing research should focus on the transformation of the present factories, towards *re-usable, flexible, modular, intelligent, digital, virtual, affordable, easy-to-adapt, easy-to-operate, easy-to-maintain and highly reliable* "Factories of the Future".

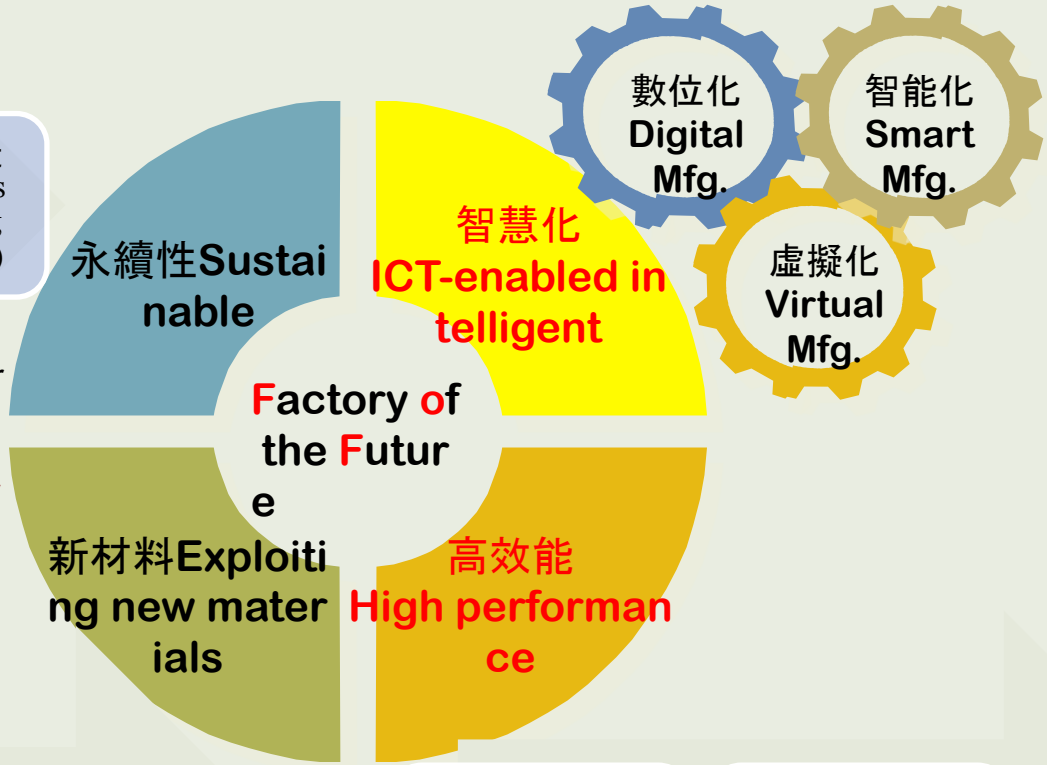
Source: Ad-hoc Industrial Advisory Group, "Factories of the Future PPP, Strategic Multi-annual Roadmap", 20 January 2010

FoF-*i*CSM各分項的重要議題

新生態工廠
New Eco-Factory model (short term)

綠色產品製造
Green Products Manufacturing (medium term)

design and produce sustainable products with drastically *reduced resource utilization (e.g., 3D Printing)* and develop advanced manufacturing processes based on *renewable resources*, and on *safety and ergonomics* for operators and users.



先進成型技術
Net-shape mfg. for advanced structural and functional materials

新製程強化材料功能
New material functionalities through mfg. processes

永續性材料加工技術
Product design using sustainable material processing technologies

彈性化生產
Flexible adaptive production equipment, systems and plants for rapid (re)configurations and optimal energy use

高精度製造系統
High precision micro-manufacturing machines and systems

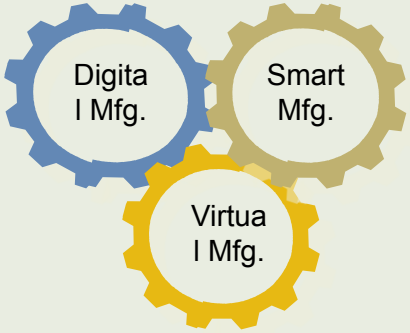
先進規劃與模擬系統
Tools for production planning and simulation for open reconfigurable and adaptive mfg. systems

適於改造與修復的製造策略Manufacturing strategies for renovation and repair

零缺點的「精實生產系統」
Zero defect manufacturing

Source: Ad-hoc Industrial Advisory Group, “Factories of the Future PPP, Strategic Multi-annual Roadmap”, 20 January 2010

ICT-enabled intelligent Manufacturing



ICT有助於改善製造系統的三個層次:

- 智能工廠 Smart factories: agile manufacturing and customization involving process automation control, *planning*, *simulation* and optimization technologies, robotics, and tools for sustainable manufacturing;
- 虛擬工廠 Virtual factories: value creation from global networked operations involving *global supply chain management*, product-service linkage and management of distributed manufacturing assets;
- 數位工廠 Digital factories: a better understanding and design of *production and manufacturing systems* for better product life cycle management involving *simulation*, *modeling* and knowledge management from the product conception level down to manufacturing, maintenance and disassembly/recycling.

Source: Ad-hoc Industrial Advisory Group, “Factories of the Future PPP, Strategic Multi-annual Roadmap”, 20 January 2010

未來工廠FoF:善用ICT的智慧化生產系統

智慧化工廠	重點	項目	狀況
智能工廠	敏捷製造與客製化	① 自我調整與可容錯的製程自動化、控制、最佳化技術與工具 ② 智慧化生產設備 (*Robot*) ③ 大型測試/驗證儀器 ④ 系統化協同式生產與控制環境 ⑤ 雷射應用 ⑥ 處理大型且即時製造資訊的新方法與工具(*intelligent* MES)	
虛擬工廠	價值創造、全球化製造與運籌	① 藉由ICT即時管理與監控全球化製造與運籌 (IoT, M2M, IoS) ② 藉由ICT保存(sustaining)產品價值 ③ 整合產品/服務系統與共創價值 (SCM) ④ 管理揮發性製造資產(全球市場相關製造與經濟資訊)	
數位工廠	製造設計與產品生命週期管理	① 完整的工程知識與分析平台 (PDM/PLM/…) ② 考量由產品設計至生產製程可交互運作的智慧型模式 ③ 易於調適的協同設計與模擬環境 ④ 全面性考量經濟面、社會面與環境面的產品生命週期評估 (LCA)模式	

4. IE 與 永續社會、永續環境、永續經濟(含生產)

東海大學

簡報完畢

敬請指教

工業工程 (Industrial Engineering)
資訊工程 (Information Engineering)
整合工程 (Integration Engineering)
創新工程 (Innovation Engineering)

anagement guru Peter F. Drucker once wrote:
he most important, and indeed the truly unique, contribution of management in the 20th cent
y was the fifty-fold increase in the productivity of the MANUAL WORKER in manufacturing. T
e most important contribution management needs to make in the 21st century is similarly to in
ease the productivity of KNOWLEDGE WORK and the KNOWLEDGE WORKER." [Drucker, P.
(1999), p. 135]