

Understanding the Manufacturing Value Chain – with case examples from China

Institute for Manufacturing

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Introduction

- Internationalisation and Globalisation
- Capability of Manufacturing Networks
- Manufacturing Value Chains?
 - From production to production networks
 - From supply chains to supply networks

=>The Manufacturing Value Chain

A broad definition

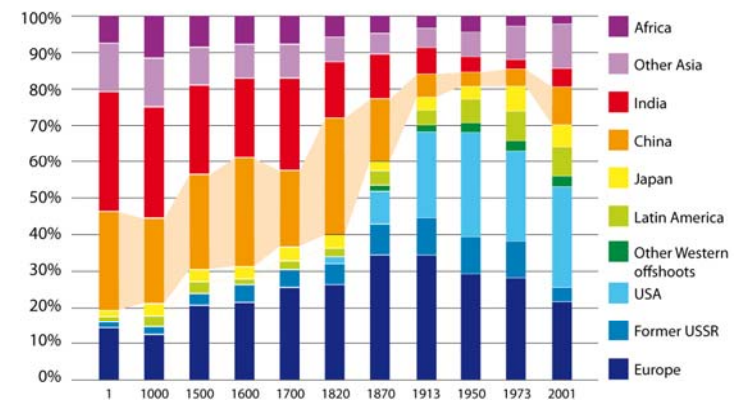
Internationalisation

- Historical context
- Increase in exports and trade
- Changing focus of demand

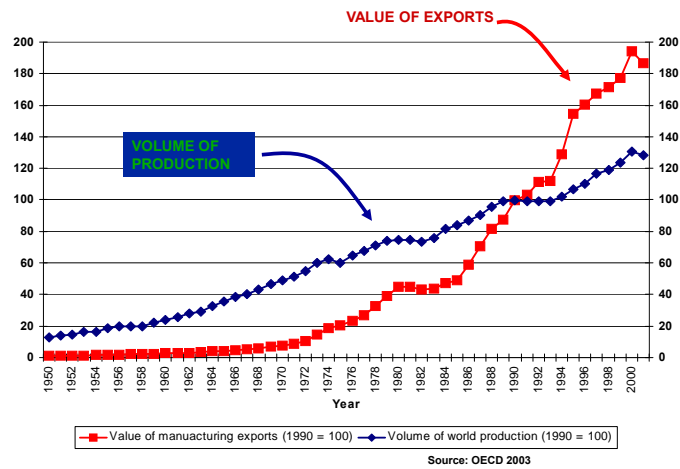
Rise and decline of powers

Share of world GDP as % of world total, in 1990 \$s

Source: Angus Maddison, The World Economy: Historical Statistics, OECD, 2--3.

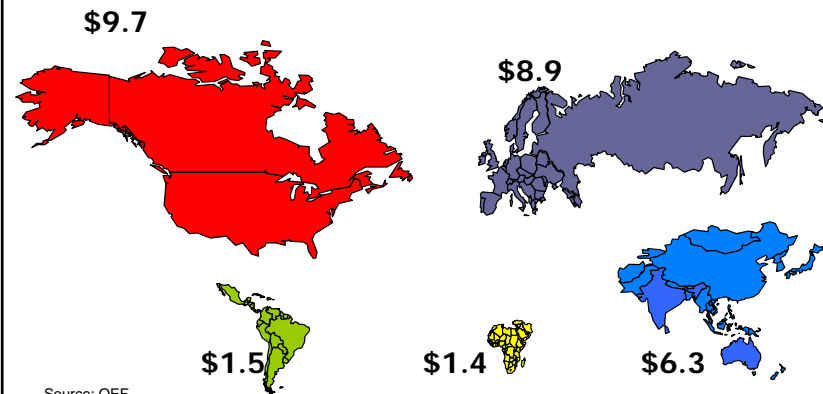


Globalisation: production and trade continues to rise ...



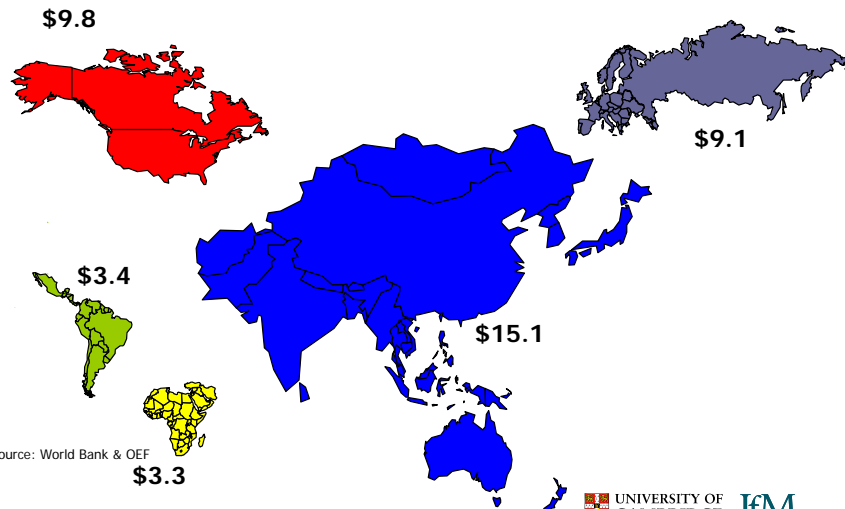
Where the Value will be

Consumer Spending 2010 (\$tn @ market exchange rates)



Where the Volume will be

Consumer Spending 2010 (\$ tn @ PPP exchange rates)



Source: World Bank & OEF

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Centre for International Manufacturing - Research themes

Networks:

characteristics of network environments

- network behaviour
- network design/configuration
- network integration and partnering models

Capability:

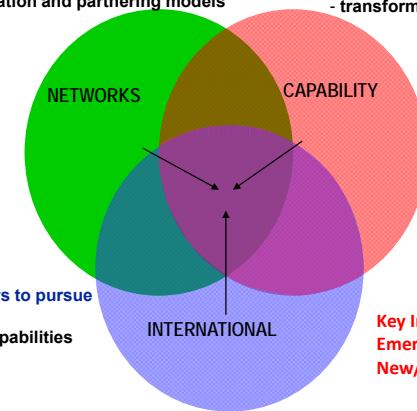
Developing system capabilities

- process development
- intrinsic capabilities of network forms
- transformation strategies

International:

crossing national borders to pursue

- new markets
- new resources/capabilities
- new technologies



Key Interrelationships

Emerging Trends and futures
New/Changing Industry structures

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Current Research Programmes

- **Global Value Networks** - mapping value chains, value capture

- **Production networks** – design of MNC manufacturing footprint
- **Global supply networks** - re-configuring SNs for enhanced capability
- **International engineering networks** – network design, through-life
- **Service operation** – integration of multi-organizational service networks

- **Mergers & Acquisitions** - delivering integration synergies and value

- **Emerging industries** – new supply network models

A common research approach to 'Network Design'

- **Research studies have focused on**
 - **Configuration theory** – structure/footprint, key elements, archetypes
 - **Capability development** – assessment, intrinsic capabilities, through-life
 - **Visualisation techniques** - mapping supply chains, VC analysis
- **Radical change** – transformation strategies, network re-design,
- **Continuous improvement** – network integration, process maturity
- **Futures** – new supply network models, changing industry structures, trends

Selected Case Examples - a historical perspective

- Production/Manufacturing Networks, 1995+
- Supply Networks, 2004+
- M&A, 2004+
- Engineering, 2004+
- Service Networks, 2005+
- Emerging Industry Networks, 2008+
- Value Chains, 2009+

A common framework for Configuration elements

Strategic management literature (Chandler '62; Rumelt '74; Miles & Snow '78; Mintzberg, '79; Kotter, 95; Miller, '96)
Operations Management literature

CIM Network configurations elements:

- structure,
- operations flow,
- governance and coordination,
- support infrastructure,
- relationships,
-
- product architecture

Configuration Elements	Global Engineering Networks (Zhang , et al. 2007)	International Mfg Production Networks (Shi & Gregory 1998)	International Supply Networks (Srai 2007, Srai & Gregory 2008)	Service Supply Networks (Srai et al 2009)
Structure	geographic dispersion, resources and roles of eng centres, and rationales for network design	Plant role, characteristics; geographic dispersion	Supply Network tier structure and shape SN Mapping Integrating mechanisms	Multi-organisational network structure Service Archetypes
Operations Flow and Processes	Coordination, including operational processes and coordination mechanisms	Horizontal/vertical coordination; operational mechanisms; dynamic response mechanisms; product lifecycle and knowledge transfer	The flow of materials and information between and within key unit operations Replenishment mode	Service supply contracting mode Through-life
Governance and Coordination	Governance, including authority structure and performance measures	Dynamic capability building and network evolution	The role of and governance mechanisms between key network partners	Service Network governance modes
Support Infrastructure	Support, including engineering tools and IT systems	-	-	Support Systems
Relationships			The role and inter-relationships, between key network partners	Partnering modes Firm and Network Value-sets
Product			Product Modularity SKU profile	Service Offering Outcomes/Effects

Emerging capabilities

- **Network Configuration analysis**
 -understanding footprint dimensions, and link to capability
 -multiple levels of analysis (common analysis framework)
 -Network design studies (based on c.50+ exemplars!)
- **Operations Strategy (and Policy)**
 - Strategic goals/drivers,
 - Reconfiguring networks, network optimisation/integration
 - Location decision, Mobility, Capability assessment
- **Initial successes**
 - Tailored network mapping approaches, Value chain analysis methodologies
 - New Multi-Organisational Network forms (GMVN, MON, EIP)
 - IJVs, M&As, Internationalisation (west-east, and Emerging Country MNCs)
 - Network integration, Partnering mode selection
 - Network Transformationfrom I to II, Mfg to Service, Mature to Emerging
 - Region/Industry/Sector/Firm levelEng/Prodn/Service/SC/VC analysis

The Manufacturing Value Chain Perspective

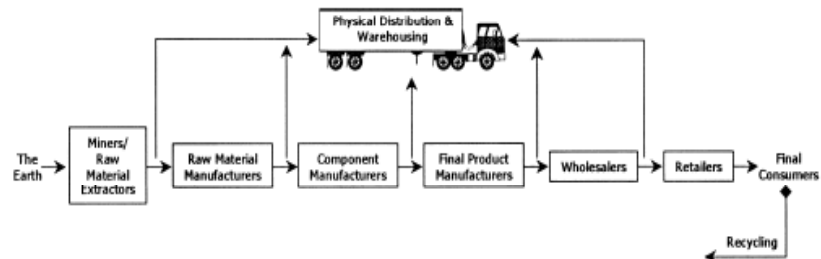
- From supply chains.....

to supply networks...

to value chains

Supply Chain

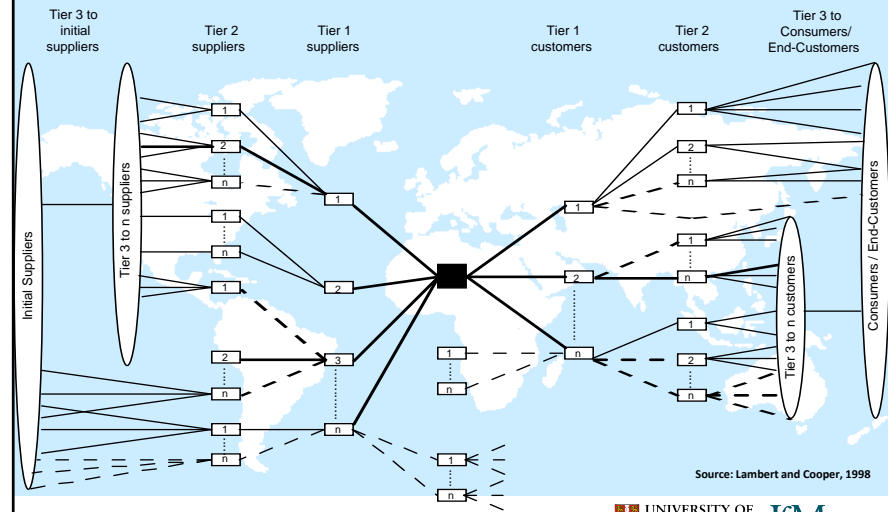
- make or buy
- collaboration mode
- partner selection
- co-operation
- co-evolution



Source: New and Payne, 1995.

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International Supply Networks



Source: Lambert and Cooper, 1998

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Approach to value chain analysis

Context:

Internationally dispersed manufacturing and supply networks

Main Processes between network players:

Identifying the main Actors

Capturing the key Processes

Network Understanding:

Linkages between innovation chain and suppliers, production, distribution, and service

Degree of 'coupling' between value chain stages

Implications for:

Enterprises: strategy, network design, network operations management,

National policy - firm level, emerging business models and industries.



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Understanding the Manufacturing Value Chain

- **Value**
 - The meaning of value, value (co-)creation and value capture

- **The importance of perspective when mapping value chains**
 - Customers, Firms (OEM), Suppliers, Product/Sector Cluster
 - Policy makers: Regional, National, International

- **Evolution of Value chains and Trends;**
 - Fragmentation, off-shoring, outsourcing.....requiring a network perspective
 - Changing Industry Structures
 - Industry Life Cycles, Network Disintegration, Network Integration
 - new Routes to Market
 - Routes to Value capture
 - Global and Regional trade
 - Disruptive Value chains / Emerging industries?

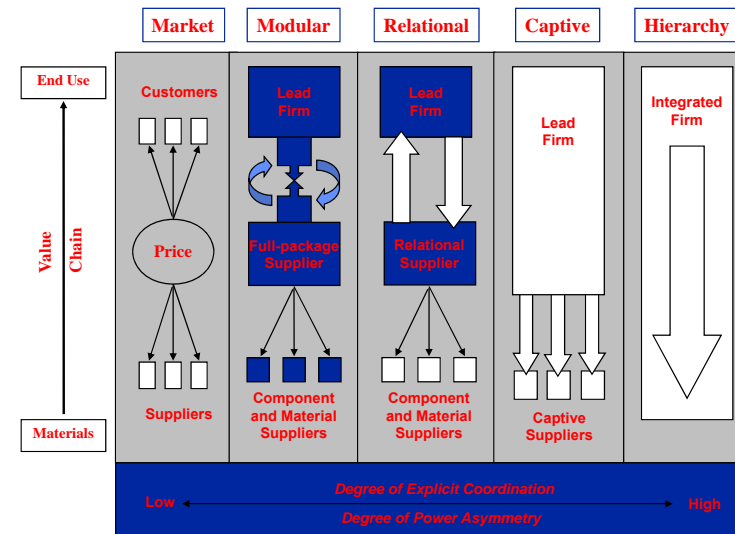
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Approaches to value chain analysis

- **Unit of Analysis:**
 - 'Product' focus: G-Profit est; 'Teardown' /BOM reports e.g. iPod (Linden et al 2007)
 - 'Customer' focus (Holweg et al 2009)
- **Unit of Analysis: Firm, supply network, and industry analysis**
 - Porters' value chain – a firm based model
 - Value Stream Mapping (Hines and Rich 1997)
 - Current State and Future State maps (Rother and Shook 1999)
 - Supply Network configuration (Srai and Gregory 2008)
 - Value creating systems that co-produce value (Norman and Ramirez 1993)
 - Changing industry structures (Jacobides et al 2007),
 - GVC Governance models (Sturgeon 2008)
- **Industry challenges:**
 - Location impact; Just-in-Time; Just-in-Sequence;
 - Firm/Country; conflict of allegiance
 - Network Design.....the global footprint.... R&D, Supply, Prod'n, Distribution, Service

Five GVC Governance Types (Sturgeon 2009)



Source: Sturgeon, 2009

Apple iPod GVC Tear Down Analysis

30 GB Apple iPod Tear Down:

Component	Supplier	Company HQ Location	Manu- facturing Location	Estimated Factory Price	Cost as % of all iPod Parts	Gross Profit Rate	Est'd Value Capture
Hard Drive	Toshiba	Japan	China	\$73.39	51%	26.5%	\$19.45
Display Module	Toshiba- Matsushita	Japan	Japan	\$20.39	14%	28.7%	\$5.85
Video/Multimedia Processor	Broadcom	US	Taiwan or Singapore	\$8.36	6%	52.5%	\$4.39
Portal Player CPU	PortalPlayer	US	US or Taiwan	\$4.94	3%	44.8%	\$2.21
Insertion, test, and assembly	Inventec	Taiwan	China	\$3.70	3%	3.0%	\$0.11
Battery Pack	Unknown			\$2.89	2%		\$0.00
Display Driver	Renesas	Japan	Japan	\$2.88	2%	24.0%	\$0.69
Mobile SDRAM	Samsung	Korea	Korea	\$2.37	2%	28.2%	\$0.67
Memory - 32 MB							
Back Enclosure	Unknown			\$2.30	2%	26.5%	
Mainboard PCB	Unknown			\$1.90	1%	28.7%	
Subtotal for 10 most expensive inputs				\$123.12	85%		\$33.37
All other inputs				\$21.28	15%		
Total all iPod inputs				\$144.40	100%		

Source: Linden et al, 2007

Summary: Value Chain perspectives in complex supply networks

- **Value capture/appropriation**
 - Defining value, high-valuefrom the perspective of multiple stakeholders
 - Does the supply network support value (co-) creation
- **Value Chain mapping**
 - Data capture needs to be selective; Capturing revenue streams, material and information flows that support targeted analysis
 - The importance of perspective; who are the key stakeholders/actors? Is location an important consideration?
- **Is there a better way to configure the value chain?**

IfM Experience

- **Supply Chain case studies**
 - e.g. for Leading MNCs: in Pharma, Aero, Auto, FMCG, Service,
- **Analyse Tier structure, main actors, key products**
 - e.g. RDA/UNIDO Sector overviews: Automotive, Aerospace, Chemicals
 - e.g. Research projects: Gaming, Medical Devices,
- **Value Chain Maps**
 - Multiple perspectives
 - Firms, Clusters, Sectors, Country overviews
 - Value chain linkages, dynamics, technology shifts
 - Future markets
 - Market development
- **Importance of Production**
 - Exemplars of HVM firm supply networks

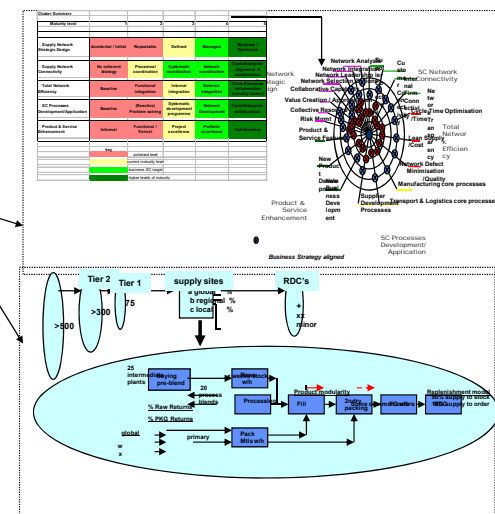
SC Consortium: capability mapping

Capability Mapping:

Configuration Mapping:

Capability and Configuration:
- linking the two variables

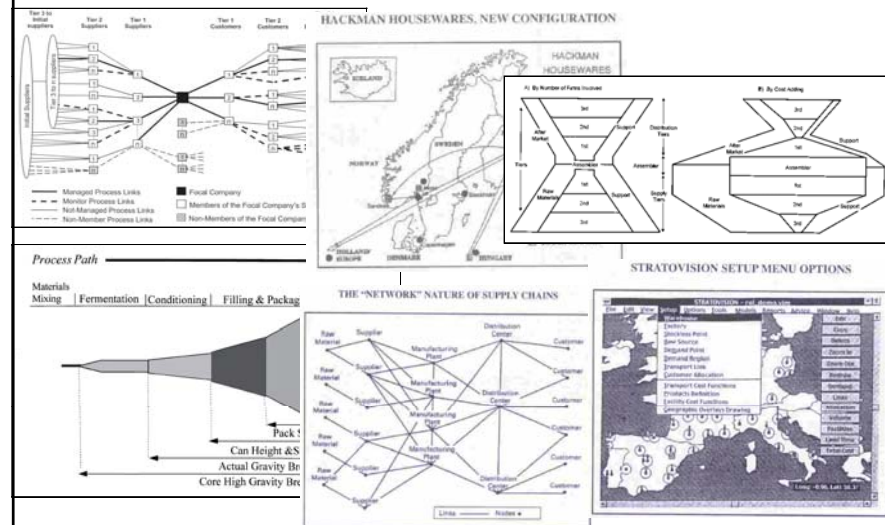
Cross-sector comparison:
- peer exchange
- process benchmarking
- performance benchmarking
- enabling processes
- mapping tools development



Mapping approaches

- **Supply chain and value chain mapping**
 - there are many different techniques to achieving this!
 - the data-set is potentially huge
 - the outputs are extremely varied in form and utility
- **Need to understand why you are doing it, and the nature of the output required**
- **Once the objectives are clear, a key task is to develop a methodology to capture a specific target data-set, for subsequent analysis and visual representation**
- **Requires a process which**
 - identifies what the key objectives and issues are
 - pilot test the method before completing a full study
 - recommendations on future supply network development.

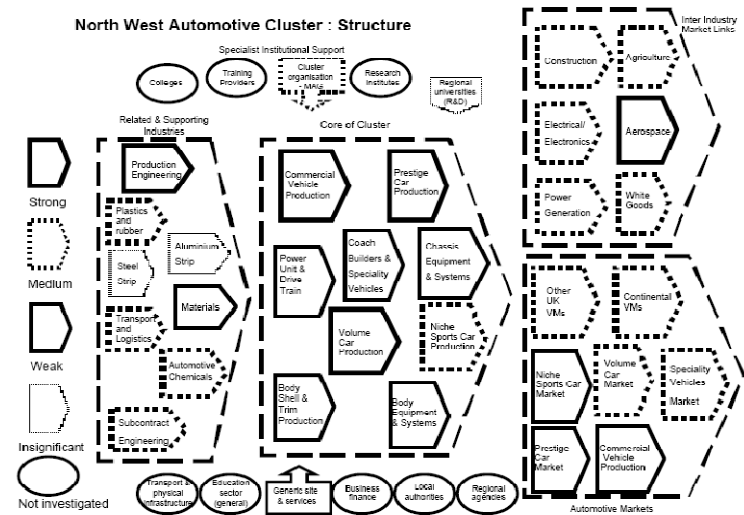
Mapping Techniques... a few examples



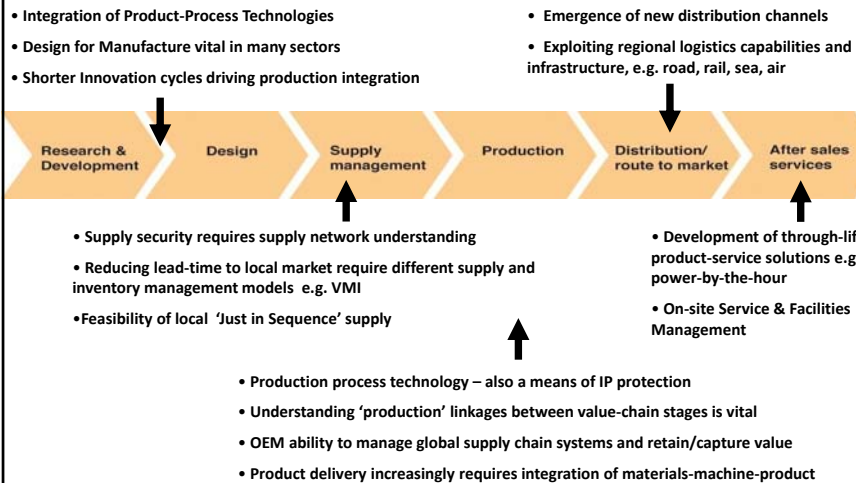
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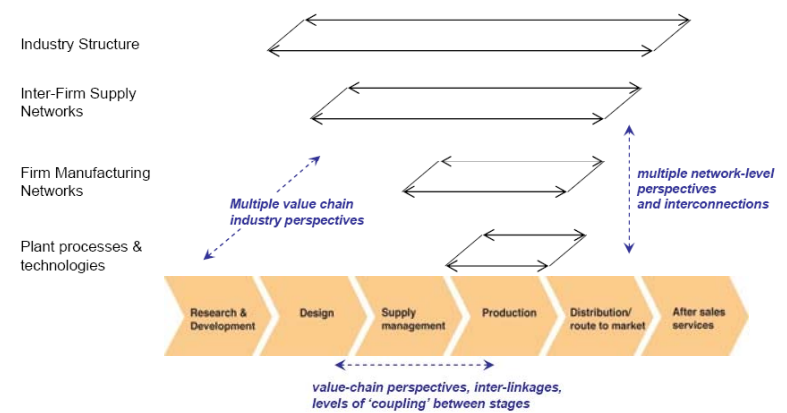
Automotive industry – a supply network cluster perspective



The importance of production in the value chain



Value-Chain of Manufacturers – Network Perspectives



China's Manufacturing Value Chain: case studies in selected sectors

— findings from China's White Goods, TFT LCD, Pharma cases

Yongjiang Shi

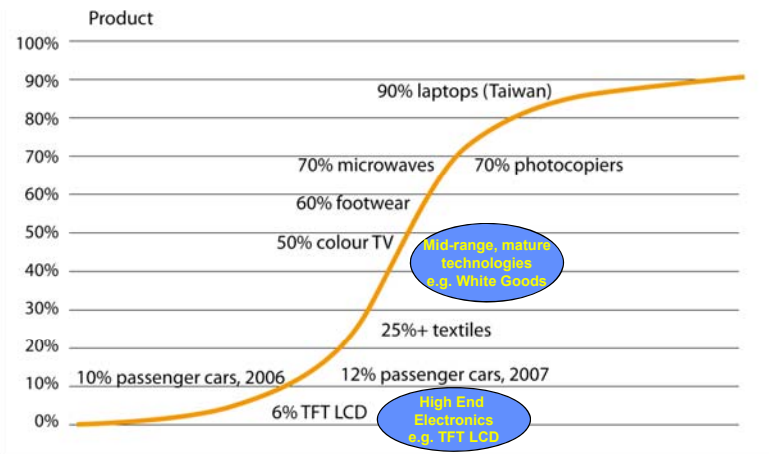
Jag Srai

Introduction: CIM Research on China

- Better understanding of the dynamics of international supply chains in selected sectors
- Explore opportunities for complementary partnering
 - Engaging with flagship Chinese enterprises
 - Explore opportunities across the value chain in key manufacturing sectors
 - Identify complementary capabilities in UK and Chinese operations
 - Workshops targeting UK firms accessing Chinese markets and manufacturing capabilities
 - Exemplar cases of integrated international value chains
- Developing research methods and tools for better understanding of Network Capability and Configuration of GVCs

China – the workshop of the world ?

% Production of global volume, 2007



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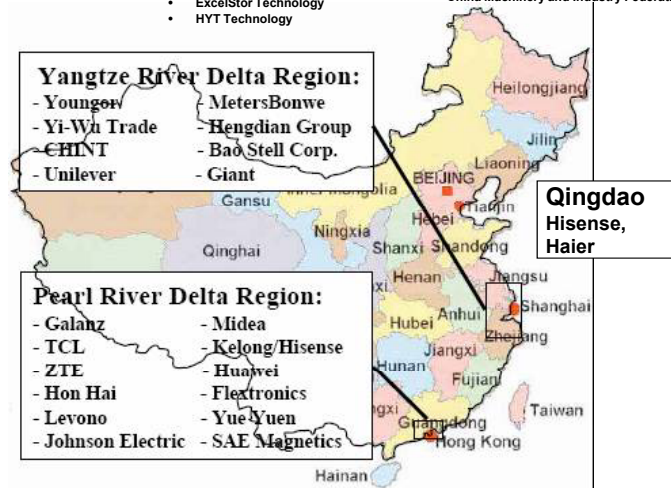
Case Studies

Company Name	Group Turnover US \$ bn (2004)	Product Category in SN case-study	Market Share Position	
			Domestic	Global
Galanz	US \$ 1.7 bn	Microwave Ovens Mfr	No.1	No.1
Midea	US \$ 4.5 bn	Microwave Ovens Mfr	No.2	No.3
TCL	US \$ 5.0 bn	Colour TV Manufacture	Top 3	No.1
Kelong/Hisense	US \$ 3.4 bn	Refrigerator Mfr	No.1	No.1
ZTE	US \$ 4.1 bn	Telecoms Equipment	No.2	-
Huawei	US \$ 5.6 bn	Telecoms Equipment	No.1	-
Hon Hai	US \$16.1 bn	Electronics Mfg Service-EMS	Top 2	Top 2
Flextronics	US \$15.9 bn	EMS	Top 2	Top 2
Lenovo	US \$ 2.9 bn	Computers and key components	No.1	Top 3
Yue Yuen	US \$ 2.7 bn	Sports Footwear CMS	No.1	No.1
Johnson-Elect.	US \$ 0.6 bn	Electric Motor Mfr	export	-
SAE Magnetics	US \$ 1.0 bn	Computer Hard Disk Drives	No. 1	No.1
Youngor	US \$ 1.7 bn	Garment Mfr – VI model	No.1	-
MetersBonwe	US \$ 0.3 bn	Garment Retailer – virtual model	No.1 Brand	-
Yi Wu Trade	US \$ 3.1 bn	Consumer Commodities	No.1	No.1
Hengdian Grp	US \$ 1.5 bn	Magnet Manufacturer	No.1 (S,F)	No.1 (H,F)
CHINT	US \$ 1.5 bn	Low Voltage Elect. Components	No.1	Top 5
Bao Steel Corp	US \$ 20.2 bn	Steel products	No.1	No.5
Unilever	US \$ 50.0 bn	Consumer Detergents - China	Top 3	Top 2
Giant	US \$ 0.7 bn	Bicycle Original Eq. Manufacture	No. 1	No. 1

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Case studies

- Rolls-Royce International Limited
- Airbus China
- Strix Innovative Technology
- ExcelStor Technology
- HYT Technology
- Ministry of Science and Technology (MOST)
- State-owned Assets Supervision & Administration Commission (SASAC)
- Guangdong University of Technology
- Institute of World Economics & Politics of CASS
- China Machinery and Industry Federation (CMIF)



Value chain highlights - China

- Frustrations with perceptions of guarded approaches to technology transfer through export controls
- Active pursuit of 'secondary' innovation with indigenous innovation being encouraged
- Design capabilities seen as a weakness with notable exceptions (Hon Hai, Lenovo)

- Service, repair and training centres focused on domestic markets appearing e.g. Airbus China



Summary Findings

- A strong infrastructure and supplier base (including OEM contract mfr) with globally leading firms in mass market products but also shipbuilding, steel and telecoms
- Chinese firms, utilising modest entry positions in the value chain (e.g. regional distributor) are rapidly entering adjacent more value added positions; 'upgrading'
- Many state-controlled enterprises have grown dramatically; 14 in Fortune 500 list.
- National strategies for manufacturing focus on **Enabling and High Tech** initiatives emphasising green, digitised, modular and reliable/sustainable manufacturing
- Policy makers questioning the benefits of low-value manufacturing; Switching to IT, pharma, and aerospace
- Current industry absorptive capacity remains low but emerging flagship companies and industries may provide models for moving from 'imitator' to 'innovator'
- Regional clusters are often highly concentrated single product category SN clusters
- Intellectual property protection remains a concern for foreign MNCs and Chinese flagship Co's
- M&A activity to plug holes in the value chain; financial capacity to do so

UK perspectives on China's Manufacturing VC

- Technology complementarities in particular providing R&D capability, and product technology support (e.g. Primary Innovation) and China's providing capabilities in 'secondary Innovation'.
 - extending clinical trials in Pharma to China, selective drug development /testing, technologies in panel display, component technology support, Contract Production (e.g. Electronics) and Service (e.g. Aero)
- Brand development
- Intellectual Property protection mechanisms e.g.
 - effective use of IP laws (increasing legal protection for Patents/Utility models),
 - enforcement best practices using public authorities (dedicated teams) and institutional cluster orgs (OTIS)
 - fragmentation of parts procurement (e.g. Li & Fung)
 - component and process accreditation/branding and selling of related services (e.g. Strix)
 - product allocation/licensing (e.g. centralised procurement agents)
 - business models that discourage imitation (ARM)
- Scope to support Chinese internationalisation - multi-domestic ops mgmt, M&As, cross-border partnering
- Rapid Prototype development in China, access to suppliers and production capabilities, and Low-cost component or product sourcing for UK firms as part of make-buy strategy development
- Increased partnering and collaboration between UK and Chinese universities
- The relatively immature services sector is set to grow across manufacturing, logistics, retail and support

White Goods

White Goods – Sector Overview

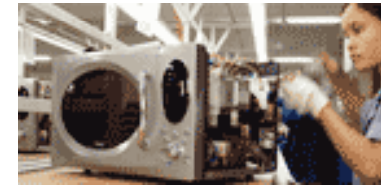
- Domestic market has grown rapidly by some 60% between 1995 and 2005
- Chinese manufacturers export focus; with 50% plus units exported
- Extreme regional concentration of manufacturers (geog./scale) in 'super clusters'
 - highly geographically concentrated *single product category* 'supply-cluster'
 - low cost (and low margins) dominate
- Few operate internationally using their own brands.
- Migration from being an outsourced, third-party factory to become independent contract manufacturers on a global scale; with product design capability
- This migration has created opportunities for UK companies who can offer skills in
 - advanced production technologies,
 - high-end component supply and
 - support with strategy and brand development.
- Secondary innovation (rather than any fundamental R&D) by some manufacturers is now emerging (Hisense, Midea, Haier) with new designs that are increasing producer-branded; driven by internationalisation ambition and with domestic consumers are becoming increasingly brand-aware

Sector Studies: White Goods – VC Models

- Galanz 'Tier 1' Mfg and Production - recently significant retail activities
- Haier Manufacturing based, Extensive Service network arm in China
- Hisense Manufacturing based; Major effort in secondary innovation
- Green Manufacturer with extensive Electrical Retail Network
- Midea International Consignment Orders, Own Brand Development, Domestic- Make to Stock model.
- OEMs Technology led heritage; now relying on outsourced contract manufacturing (and design)
- STRIX UK Component Manufacturer; China/UK operations supply to OEM & Chinese Contract Manufacturers

Domestic appliances - Galanz

- **Largest microwave oven production base in the world**
- **Annual production capacity of 15 million units 11,000 employees.**
- **Turnover \$700m**
- **70% of China market,**
- **40% of global market.**



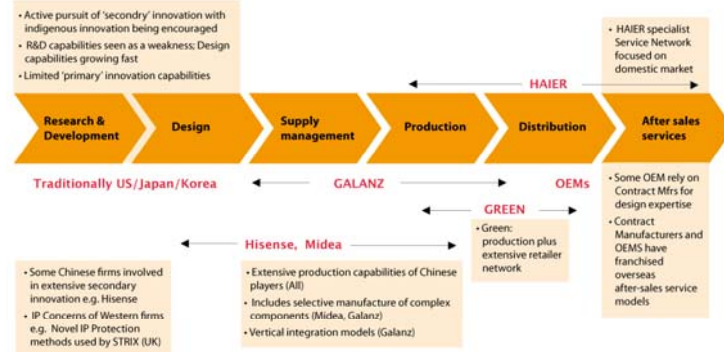
Midea – Home Appliances



- Global player in Home Appliances
 - \$4.5 bn Sales (2004); \$1bn exports
 - 8 focused factories – all in China
 - 50,000+ employees
 - Products – top 10 global manufacturer
 - Microwaves – 25% global market
 - Air Conditioners, Refrigerators
- Microwave factory based in Shunde
 - same city as Galanz
 - ongoing capacity upgrades
- History
 - Group founded in 1968
 - late entry into the MW mass-market
 - following Galanz entry in 1992
 - Market position; No.2 -China, No.3 -Global

Value chain highlights – China

White Goods Household Appliances



White Goods: Value Chain highlights

- Migration path:
 - From local regional distributors or small-scale third-party contract manufacturers to global
 - Demonstrating dynamic capabilities to rapidly move into adjacent value-chain activities,
 - multiple value-chain footprints have emerged incorporating alternative approaches
- Profitability is a major issue
 - need to gain independent access to both innovation and markets.
 - Whereas indigenous innovation is a key national policy, few firms are making serious investments in this area; a "r &D" strategy
 - opportunity for UK firms is providing primary research at component and product levels
- Internationalisation strategies aim to
 - Break the dependence on OEMs and Retailers from advanced economies
 - Or move beyond contractual cost-based negotiations.
 - Market access and after-sales services present partnering opportunities or potential M&A
- Production
 - A sole focus on contract production leaves Chinese companies in a highly vulnerable position
 - Lack of automation in production, and the high labour turnover at shop-floor levels, may represent some opportunity for introducing improved production technologies.

White Goods - Emerging Models

- The development of alternative positions in the value chain by Chinese Contract-MS
- Internationalisation strategies involving partnerships with o/s specialist retailers
- A requirement for some manufacturers to improve quality through production technologies in order to compete with high-end products in advanced economies
- Labour-law changes impacting PRD region may require a re-think on the use of temporary labour and the greater adoption of automation in production, or relocation
- Material price-inflation forcing a re-examination of the pricing strategies of many manufacturers
- indigenous innovation currently practiced by a few players and focused on secondary innovation will determine those players who will be able to compete internationally.
- The fierce price-competition in the sector points toward some future rationalisation
- Importance of after sales services in some product categories.

White Goods: Potential UK-China Complementarities

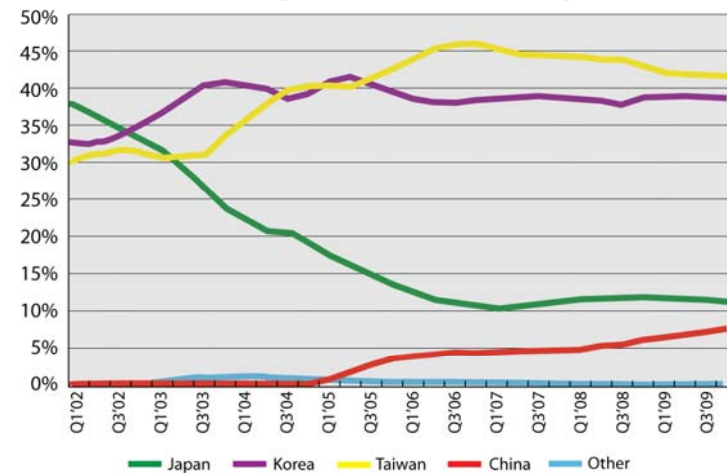
- 'Internationalisation' process development through a more partnered approach with technology providers (product and process), retailers and service centres
- Brand development/acquisition opportunities
- Primary innovation support in terms of next generation products
- Introducing more advanced production technologies to improve quality yet further
- High-end component supply
- Supporting firms in strategy development and their value-chain analysis.
- The value-chain models are appearing to diverge from their traditional contract production heritage, each representing different strengths
 - Potential for support are thus becoming more company specific (see chart)
 - 'Gaps' in the value chain of these Chinese firms, whether as a result of strategic decisions or capability gaps, represent potential opportunities for partnering

TFT LCD

TFT LCD – Sector Overview

- Thin-film transistor liquid-crystal displays (TFT-LCDs) are a variant of liquid crystal displays (LCD) using thin film transistor (TFT) technology to improve image quality.
- TFT-LCD is the largest sector in electronics industry with sales c. \$78 bn in 2007.
- Since 2004 the revenue of TFT-LCD sales have overtaken traditional CRT (Cathode-Ray Tube) sales and has become the largest electronics sector globally.
- TFT LCD technology replacing CRT displays in television manufacture; now the dominant platform.
- Chinese manufacturing companies are still in the early (incubation) phase of industry activity.
- Taiwanese and Korean companies have had production plants for some time in China.

Sector studies: TFT-LCD Competitive landscape



Sector Studies: TFT LCD – VC Models

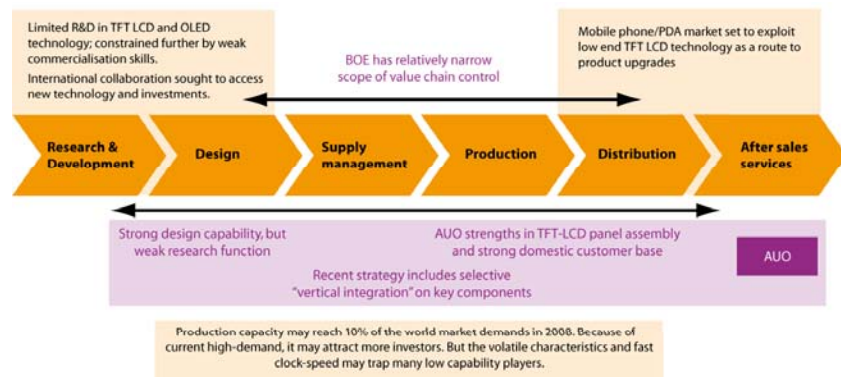
- TV OEMs:
 - Multinationals: Samsung, Philips, LG, Sharp, Panasonic, SONY, NEC
 - Chinese Indigenous TV OEMs: TCL, HiSense, Changhong, Haier ...
- TFT LCD Manufacturers:
 - Japan: Sharp, IPS, and SONY
 - South Korea: Samsung, LG/Philips
 - Taiwan: AUO, CMO, CPT, Hannstar, Innolux
 - China: BOE, SVA-NEC, IVO
- Key Component Suppliers:
 - Conning; Toppan; Nitto Denko; Stanley, Nippon ED; Samsung, NEC

TFT LCD: Case Study Companies

- AUO :
Taiwan's TFT LCD Manufacturing company. AUO, with sales US\$14.8 billion in 2007, is the largest TFT LCD company in the world. It has 16 factories in Taiwan and 3 factories in China.
- BOE (Beijing Orient Electronics):
Chinese state-owned TFT LCD manufacturing company. Acquired Korean Hydis in Jan 2003. After several years managing the integration of the firms; both production capabilities spanning both countries, and integrating worldwide market demands, BOE is emerging as a strategic player in China with the latest 5th generation production line and new product development capabilities.

Value chain highlights

TFT – LCD Industry



TFT LCD: Emerging Models

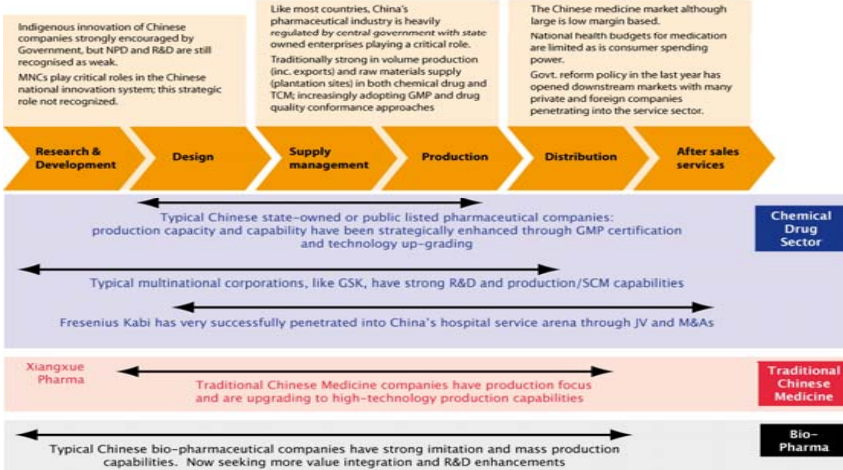
- Rapid evolution and internationalisation of emerging high clock-speed industries;
 - the technological invention was in Europe,
 - commercialised in the USA,
 - technology transferred to Japan and then
 - extended to mass production by Japanese, Korean and Taiwanese companies.
 - Now Chinese firms are focusing to grow the domestic business.
- Collaboration models
 - Japanese companies increasingly high-end technology focused having withdrawn from mass production
 - Japanese companies collaborating with Taiwanese production centred companies,

Pharma

Pharma - Case Study Companies

- Fresenius Kabi: German MNC
 - Leading position in infusion therapy and clinical nutrition.
 - 17,000 employees worldwide and 2 billion Euro in 2007
 - 45 manufacturing facilities spread across the world.
 - Fresenius set up its first JV in Beijing in 1994, and, then in 1999, acquired Sino-Swed Pharmaceutical Corp (which had been in China since 1982).
 - Fresenius Kabi has become one of the largest MNCs in the Chinese pharmaceutical industry.
- Xiangxue: Zhuangzhou based TCM company.
 - Its products cover a wide range of TCM families.
 - Achieving GMP standards and coordinating whole supply chain
 - Focuses its R&D on upgrading TCMS by identifying and purifying active ingredients in TCM.
 - In 2007, it set up an R&D team in the Pharmacology Department of Cambridge University.

Value chain highlights – Chinese Pharmaceutical Industry



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Pharma: Emerging models

- A global value network is emerging in the industry:
 - GSK's Chinese and Xiangxue's UK R&D centres; and Fresenius's Chinese health care industry engagement demonstrate exploitation of global value networks
- The strategic "make or buy" decision has moved beyond the traditional outsourcing or offshoring decisions
- Chinese firms started to internationalise their value chains:
 - Export and contract manufacturing service have been traditional Chinese manufacturing strengths
 - Chinese manufacturing companies have started to engage with foreign resources to equip their manufacturing systems, upgrade R&D capabilities and improve clinical support practice.

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Some Observations from Sep 2009

- **What downturn?**
 - rapid return to fast growth...
 - data from Zhejiang +3% (q1), +9% (q2)
- **Long term planning by the state**
 - sector road-maps that set out priorities through to 2050
 - Serious about 'green manufacturing'
- **'Open Manufacturing'**
 - 'Shanzhai' model driving innovation in electronics
 - Fragmentation of manufacturing, rapid 'unofficial' prototyping
 - Loosening of control by the established players

Forward Research Activity

- **Develop value chain mapping and analysis methodology**
 - Pilot studies on 'typical' sub-sector, or complex firm supply network to:
 - demonstrate style/content of outputs, inform realistic scope and schedule
- **Pursue further studies of selected sectors ensuring where possible:**
 - quantitative understanding of tier structure and dynamics
 - engagement – continuing if possible – of key 'actors'
 - identification of generic and sector/firm specific issues and challenges
- **Publication of maps to inform industry and policymakers**
 - track industry dynamics and emergence