Cross-sectoral innovations in techno-industrial systems: Lessons from Emilia Romagna.

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&
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Outline

1. Metals, mechanics, mechatronics and beyond: a manufacturing system perspective

2. New value creation/capture opportunities and structural innovation dynamics: interdependencies & mechatronics platform

3. Cross-sectoral innovations in ER: common technology systems and manufacturing linkages
   - Cambridge University Research project on Manufacturing linkages – Electro medical devices (Antonio Andreoni, Eoin O’Sullivan and Michael Best)
   - Research project on Automation synergy – Packaging machines, Pharma segment (Antonio Andreoni, Giorgio Prodi and Marco Bertinelli)

4. Industrial policy implications
Metals, mechanics, mechatronics and beyond: a manufacturing system perspective

- The strategic role of the metal-mechanic sectoral system

  ✓ Value creation: Engine of growth, specialisation and technical change
  ✓ Value creation and capture: Macroeconomic stability and balance of trade

- What is its broader strategic role in the modern manufacturing system?
Metals, mechanics, mechatronics and beyond:
a manufacturing system perspective

Division of labour/production tasks, specialisation and new sectors development

Adam Smith
“The Wealth of Nations”, 1776

Mechanical computer: First mechanical computing machine and the new manufacturing system

Charles Babbage
“On the Economy of Machinery and Manufactures”, 1832
Metals, mechanics, mechatronics and beyond: a manufacturing system perspective

- Modern manufacturing systems consist of complex interdependencies, often across a range of industries, which contribute a variety of components, materials, production systems and subsystems, producer services and product-related service systems.

- Modern manufacturing companies orchestrate production processes through complex producer networks spanning across countries, as well as different industrial sectors.
Metals, mechanics, mechatronics and beyond: a manufacturing system perspective

The multi-layered architecture of modern mfg systems

STRUCTURAL LAYER: Overlapping sectoral value chains

OPERATIONAL LAYER: Sectoral value chains are decomposable in functional stages of production

ORGANISATIONAL LAYER: Variety of mfg system actors (drivers, complementors, contractors, specialists, intermediaries)

TECHNOLOGICAL LAYER: Variety of technologies (enabling platform technologies, infratechnologies, production technologies, proprietary technologies etc.)

Metals, mechanics, mechatronics and beyond: a manufacturing system perspective

The multi-layered architecture of modern mfg systems

New value creation/capture opportunities and structural innovation dynamics

- Processes of **value creation and national value capture** are changing in nature
  1. Value is **nested** in specific functional tasks
  2. Value is **created** through the combination (and recombination) of increasingly complex technology systems and platforms (also production technologies & competencies)
  3. Value is **captured** by major companies (system drivers) commanding critical stages of sectoral value chains
New value creation/capture opportunities and structural innovation dynamics

- **Structural innovation dynamics are also changing in nature**
  1. The most innovative economies are those endowed with *manufacturing scaling-up competencies* (PIE-MIT)
  2. Innovations are enabled by *technology platforms* (such as nanotechnology, micro- and nanoelectronics including semiconductors, advanced materials, biotechnology and photonics, *mechatronics application*)
  3. Cross sectoral innovations: *applications of similar technical innovative solutions across and within sectors*
Cross-sectoral innovations in ER: common technology systems and manufacturing linkages

What makes the Emilia Romagna techno-industrial system more competitive?

- **Medical device valley** (90/120 companies, leading cluster in Europe for disposable and electro medical devices for haemodialysis and cardio surgery)
- **Plastics valley** (co-moulding, injection moulding machines etc.)
- **Packaging valley** (30% global market shares, food, pharma/medical and healthcare – IMA, Marchesini, Sitma, Sacmi etc.)

...And many other ‘**hidden champions**’ in the metal-mechanics sector such as TREVI (deep foundation engineering, tunnelling, geothermal energy) or agrotech sector such as Dinamica Generale (on-board solutions, precision feeding, agri solutions)
Cross-sectoral innovations in ER: **common technology systems and manufacturing linkages**

The existence of a ‘**common’** set of core industrial competences and capabilities underpinning:

- the successful **clustering** of multiple companies producing similar (technologically similar) class of products
- the **overlapping and ‘compulsive sequence’ of innovation dynamics within and across sectors**: from mechanics to electronic machines, from automation to robotics, from advanced materials to smart products, from precision engineering/mechanics to critical system products...
- A dynamic inter-sectoral process of structural change whereby different sectors evolve at **different speeds** and trigger **technology push-pull dynamics**
Cross-sectoral innovations in ER: common technology systems and manufacturing linkages

Electro-medical devices rely upon a complex mix of platform based technologies and an inherently different (although highly complementary) spectrum of capabilities and underpinning competences in **electronics, software, mechanics, plastics, mechatronics, pumps and fluid control systems.**

Cross-sectoral innovations in ER: **common technology systems and manufacturing linkages**

- **Fluid system**
  - Pumps, valves...

- **Flow system**
  - Plastic tubes, micro-tubing...

- **Filtration system**
  - Mechanical filtration, membranes...

- **Control system**
  - Load cells, heat exchanger...

- **Electronic system**
  - Sensors, embedded mechatronic apps, software...

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<th>Table 1: Specialist Contractors, case studies</th>
<th>Competencies</th>
<th>PUSH &gt;</th>
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<td>Lean</td>
<td>Small size: 1995</td>
<td>Production</td>
<td>Operations/Management</td>
<td>Enabling</td>
<td>Product-opportunities within biomed</td>
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<td><strong>Core technology Domains</strong></td>
<td>-Flow system -Fluid management -Pumps -Valves -Special connectors -Vol. flow meter -Dynamometer cells</td>
<td>-Compounding -Pilot moulds -FIA -micro extruders (internally produced) -Tri &amp; four layer extruders -Clean rooms</td>
<td>-Customisation -Certification -Risk reduction</td>
<td>-Bridging R&amp;D -Component/product testing and risk analysis -Patent analysis</td>
<td>-Multi lumen/layers microtubes -Braided &amp; armoured tubes -Flexi/modular tubes</td>
<td>-Biomedical -Biomedical -Automotive To -Aerospace -Industrial To -Pharma Specials -Chemical To -Components &amp; subsystem design -Engineering -Prototyping &amp; PS To -Scale up -Certification -Post sale services</td>
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<td><strong>FLUID SYSTEM</strong></td>
<td>ENKI</td>
<td>Small size: 2002</td>
<td>Production</td>
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<td><strong>Core technology Domains</strong></td>
<td>-Tubes -Catheters -Balloons -Micro components in plastics -Polymers -Photronics</td>
<td>-Compounding -Pilot moulds -FIA -micro extruders (internally produced) -Tri &amp; four layer extruders -Clean rooms</td>
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<td><strong>ELECTRONIC SYSTEM</strong></td>
<td>EGICON</td>
<td>Turnover &gt; 5mio euro</td>
<td>Production</td>
<td>Operations/Management</td>
<td>Enabling</td>
<td>Product-opportunities across sectors</td>
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<td><strong>CONTROL SYSTEM</strong></td>
<td>Dinamica Generale</td>
<td>Medium size: 1990</td>
<td>Production</td>
<td>Operations/Management</td>
<td>Enabling</td>
<td>Product-opportunities within biomed</td>
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<td><strong>Core technology Domains</strong></td>
<td>-Load cells -Bio indicators -Control units -Pressure sensors -Near infrared spectroscopy</td>
<td>-Fully automated production lines -Controlled production environments -Machine tools (internally produced)</td>
<td>-Product development management -Mgt of certified subcontractors -Customisation -Certification -Risk reduction for focal firm clients</td>
<td>-Bridging R&amp;D -Research Lab Component/product testing and risk analysis -Patent analysis -Multi markets analysis</td>
<td>-Wtighing systems -NIR solutions -Integrated control systems</td>
<td>-Incubator monitoring -Blood circulation control unit -Automated zootech systems -Precision feeding systems</td>
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<td><strong>FILTRATION SYSTEM</strong></td>
<td>GVS</td>
<td>Big size: 1979</td>
<td>Production</td>
<td>Operations/Management</td>
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Cross-sectoral innovations in ER: common technology systems and manufacturing linkages

Packaging machines have evolved, over the past two decades, from an architecture based on mechanical components, into a combination of mechanical transmissions, robotics, interfacing electronics, and control software. This modularity prompting the need for new production capabilities, pave the way for a totally integrated mechatronic platforms.
Cross-sectoral innovations in ER: common technology systems and manufacturing linkages

Italian Machines VS German Machines (Avg)

IMA Perception VS German Suppliers (CP)

Cross-sectoral innovations in ER: common technology systems and manufacturing linkages

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Automation Profiles:
Different configuration of automation subsystems based on the same core-competences

Mechatronic platforms with customized software and high precision and ad hoc mechanical solutions

Industrial policy implications

• Sectoral policies are increasingly substituted by/combined with cross-sectoral policies aimed at picking cross-cutting technologies: major focus on general purpose technologies, enabling technologies, multi-KETs and platforms development.

• Increasing emphasis on ‘selective learning’ and technological infrastructure provision for reducing the risk involved in technological change, scaling up production and addressing manufacturability challenges: focus on infra-technologies and quasi-public good facilities for specialist contract R&D, rapid prototyping, quality/standards development...

• Multi-layered industrial policy models have been increasingly adopted to respond with more flexibility to the complexity of modern manufacturing systems, however raising challenges with respect to governance and enforcement.

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References

