Technology, Industry 4.0, Globalisation

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Vertical Integration: In-plant information systems

1. Software for **machine-to-machine (M2M) connection**: the whole system is connected to a server;

2. **ERP (SAP)**: to record and manage
   - Parts and components supply orders
   - Production orders
   - Problems, downtimes, etc.
   - Final production

3. **MES**: to deliver work-orders to production lines on a daily basis
   - identification of current production stage and specific operation in progress with immediate detection of problems;
   - tracking what each worker does in any moment (optical scanners, touchscreen PCs, bar codes);
   - tracing the production process as a whole.

4. **Workstream**: infrastructure based on MES:
   - workers move batches from one machine to the other, keeping track of manufacturing process;
   - automatically processes operations, follows them in real time and interact with the different machines.

Horizontal Integration: connection with other plants

1. Great importance of **connections**:
   - between plants belonging to the same Group but located in different places/countries
   - with suppliers, which can themselves be located abroad.

2. **Centralised software systems** to coordinate the various stages:
   - **APS (Advanced Planning and Scheduling)**: software tool to enable management of resources: short-medium run planning of plants productive capacity
   - **MRP (Material Resources Planning)**: software tool for warehouse management, detecting and notifying inputs required to meet a specific order (to be produced or purchased)
   - **ERP (normally SAP)**: software tool for managing the whole production process, including supply orders
     - imposing kanban logic to external suppliers: high degree of integration of production chains
     - suppliers share the same computer-based management system: orders delivered by simply pressing a button in the logistics office

Horizontal Integration: Example

- Huge companies develop specific purchasing strategies which strongly affect suppliers
- Example: the decalogue defined by **CNH Industrial for its suppliers**:
  1. open orders;
  2. last-minute changes of supplies;
  3. suppliers must communicate their working times (vacations, closures, shifts, etc.);
  4. penalties for supplies delivered in advance/on delay.
- **Just-in-sequence production**: parts and components to to be supplied in a specific sequence defined by production plan and cycle:
  1. Supplies management: **Junjo** (sequential calls);
  2. **Kanban** cards collected daily and then electronically delivered to suppliers;
  3. managed with informatic systems to share information with suppliers, track daily/weekly orders and delivery schedules, etc.

New technologies: reorganising working times

- **Software tools** allowing:
  1. production planning (generally on weekly basis);
  2. operations scheduling (on daily or shorter basis);
  3. production orders delivery to departments, lines and workstations;
  4. real-time rescheduling of work orders;
  5. recording of concluded stages with times and possible problems

- **Operation times reduction:**
  - **not bargained** but unilaterally imposed
  - precondition for lean production, just-in-time/sequence, WCM:
    1. compliance of supplies deliveries to planning
    2. synchronisation of production stages
    3. high degree of variability of workloads and production mix

- **Work orders**: barcodes embed cycle times based on machine times:
  1. workers' tasks complementary to machines': loading and unloading
  2. workers in charge of operating more than one machine at the same time
  3. additional tasks (self-checks, quality control, filling in production sheets, etc.)
  4. data immediately uploaded through ERP or MES.

Control

- Introduction of **devices for remote control** of plants and equipment/work performance
- ERP/MES and optical readers: **matching barcodes** associated with:
    1. workers
    2. machine they operate
    3. batch which is being produced
    4. specific component under process
- **Machines also generate data** about production volumes, downtimes (breakdowns, set-up, controls, lack of materials, tooling, etc.)
- This **monitoring system** often involves:
    1. **suppliers**: can connect to machines for remote maintenance
    2. **customers**: can monitor in real time the testing process
- Companies can achieve **additional goals**:
    1. computing production costs
    2. compute the cost of each worker
    3. decide whether to externalise or not some specific production stages, possibly to low-cost countries.

Man/Machines relation

- Production plans and machine scripts:
  1. elaborated by planning and engineering departments
  2. supplied by companies supplying equipments
- Scripts uploaded by programmers, even remotely;
- Once uploaded scripts are not always launched by workers, but by:
  1. head of the department or production responsible;
  2. optical readers: barcodes associated to batches associated to scripts;
- Workers unaware of data and scripts by which the system works:
  1. More advanced tools do not imply higher level skills;
  2. Neither machines equipment is part of workers' tasks;
  3. Workers only in charge of supporting tasks;
  4. Machines' increased autonomy: higher degree of skill saturation;
  5. No human control on workers anymore: machines are indisputable;
- Strategical decisions not dictated by technological necessities: specific social decision
- Programming requires computer science skills, but workers could be involved in discussing software and scripts goals

Automotive GVCs

- Automotive production is by far the one triggering the highest proportion of EU employment in all countries
- The inter-industry networks deploy all throughout Europe, and beyond it. Eight GVCs, with their heads in as many countries, emerged as being relevant for EU employment
  - Five of them have their head in western EU: Germany, France, GBR, Spain, Belgium
  - three have their head in eastern Europe: Czech Republic, Hungary and Slovakia.
- Of course, the most important automotive GVC is the one headed by Germany, which is by far the country triggering EU production and employment to the greatest extent

Germany

- Germany strongly reduced its domestic participation in the Vehicles GVC, shifting a considerable amount of production activities abroad

- In particular, the weight of eastern EU countries increased: with EU enlargements, these countries started supplying automotive components which in their turn were the result of assembling less specialised parts coming from countries located at the periphery of the EU, such as Turkey

- We can conclude that Germany resorted to western EU countries, such as Italy, for high quality componens (e.g. dashboards for Porsche), while shifting the remaining purchases to the East.

Other western EU countries

- **Spain** did not change as much the structure of its automotive GVC: it just shifted part of its first-tier purchases from western EU to eastern EU countries and Portugal, without any revolutionary structural change.

- The difference with respect to to Germany emerges, however, when looking at the **role of China**, which became an important supplier of **machinery modules**.

- The domestic participation of **French**, and to an even greater extent **Belgian**, economic systems to their own automotive GVCs seems increasingly confined to the assembly of part and components coming from abroad; also in this case, the role of eastern EU is increasing and increasingly specialised in first-tier supplies.

- The **UK** followed a partially different trajectory, shifting part of its purchased to extra EU countries – which is somehow consistent with Brexit.

Eastern EU countries

- **Czech Republic** shifted its purchases of relatively low labour intensive intermediates from Germany to Korea, or to other Eastern Europe countries, and that of labour intensive stages to Turkey and Poland.

- **Hungarian** automotive chain somehow followed a trend similar to that characterising French and Belgium, of course on a different scale and with some country specificities, moving towards the specialisation in the assembly of imported components.

- **Slovakian** automotive GVC also shifted its purchases from Germany to Austria and to labour intensive countries in Eastern Europe, with a further shift to India for basic industry, Turkey for labour intensive automotive components, and China for machinery modules

General trends

- Eastern EU countries specialised in the production and provision of first-tier, low labour intensive automotive components, with a parallel despecialisation in almost all other more basic industries
- This specialisation entails a strong dependency on the heads of GVCs as concerns investment decisions (capital accumulation) and development trajectory
- Were Germany to find out a way of further reducing the cost of supplies by shifting supply relation to other, lower cost, countries, eastern EU states would end up with a totally displaced production matrix.
- In general, supply relationships are increasingly dependent on the decisions and needs of OEMs, which demand just-in-time and just-in-sequence deliveries
- With customization of the characteristics of these components, a symbiotic relationship between OEM and suppliers emerges, which makes a possible conversion of production very difficult.
- Despecialization in less specific sectors, such as Basic Metals, Fabricated Metals, etc., aggravates the problem

Non-EU countries

- **Turkey**
  - Turkey became more relevant in the production of relatively labour intensive automotive components, which suggests it supplies eastern EU countries which then supply western EU ones
  - In its turn, the country reduced the relevance of its supplies of less specialised intermediates such as Textiles and Rubber Plastic in favour of India
  - The production chain seems to run as follows: India supplies Turkey with these low-quality intermediates; Turkey uses these intermediates to produce labour intensive components which it then sells to eastern EU countries, which in their turn supply Germany.

- **China** increased its relevance in almost all EU automotive GVCs, but did not at all develop any kind of dependence: Chinese production matrix, as regards this supply relations, on the contrary became more and more complete and complex, and direct and indirect deliveries to the EU more and more heterogeneous.