THE RISE OF THE INTELLIGENT ENTERPRISE

Intelligent Enterprises (IE) streamline and integrate their processes by implementing advanced technologies and acknowledged best practices, becoming more resilient, sustainable and profitable. Two fundamental technologies in IE are Advanced Planning and Scheduling Systems (APS) and Advanced Internal Logistics Systems.

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More and more companies face changes to their business, with a growing demand for customised products, the introduction of new ones, and an increased product mix. This reality leads to increased shop-floor complexity, with more processes to manage, tools to share between concurrent operations and a demand for limited specialised resources, required by multiple work stations during the setup/changeover operations, or to monitor the execution of operations.
If, at a given moment, the production flow is stable, with sufficient resources, and one is able to comply with delivery dates, at another moment, the changes in product demand mix could lead to delays and a lack of information to understand what has changed and how one should act in order to re-establish balance.
This context justifies the need to develop intelligent production systems and, consequently, to evolve towards the Intelligent Enterprise!
Intelligent Enterprises (IE) streamline and integrate their processes by implementing advanced technologies and acknowledged best practices, becoming more resilient, sustainable and profitable. The IE implements a strategy that enables rapid transformation of knowledgeable data – maximising process innovation, automation and optimisation. The IE resort to emerging technologies like artificial intelligence (AI), machine learning (ML), Internet of Things (IoT) and analytics to connect people, equipment and systems. These technologies will further allow the workforce to perform higher value-added tasks and the enterprise to be more agile and benefit from sustainable growth.
An IE must invest in process automation, optimisation and a set of so-called intelligent and integrated applications, supported by a digital platform that enables acquisition, the establishment of relations and orchestration of data originating from the entire enterprise, its clients and suppliers. The use of intelligent technologies will enable data processing, resulting in pattern detection, forecasting the impact on results and suggesting improvement actions.[1]
Two fundamental technologies in IE are Advanced Planning and Scheduling Systems (APS), namely for determining when and under which circumstances the industrial processes will take place, and Advanced Internal Logistics Systems, given their ability to apply the APS decisions at the shop-floor level. In the following section, we present these two technologies, perceived as structural for IE.

Advanced tools for Planning and Scheduling (APS)

The planning and scheduling of production orders are widely known as critical production management activities, which enables companies within a variety of sectors to differentiate themselves at operational performance level.
However, mapping complex production systems and their restriction, while simultaneously providing optimised scheduling solutions in due time, is not an easy task.
Many industrial companies with sophisticated ERP and MES systems still use planning and scheduling systems based on spreadsheets, supporting their execution in outdated information normally gathered through daily-run batch processes or at multiple-hour intervals. These limitations usually require manual adjustments to the initial plans before they can be deployed to the shop-floor.
As technology advanced, planning and scheduling systems evolved, modelling reality more precisely. At the same time, manufacturing production systems have also become increasingly complex and dynamic, enforcing planning and scheduling systems to keep up with this evolution.
If an APS is not able to model the manufacturing production system faithfully, including its constraints and behaviour, then it will be incapable of producing optimised plans. In order to achieve this, APS must become increasingly more sophisticated and intelligent, i.e.:

➵ Stay connected and constantly updated with available information by all systems that form the IE, as a mandatory condition to generate optimised plans.

➵ Have a flexible internal information model that enables changes to the manufacturing system (e.g., through the implementation of new constraints).

➵ Continuously monitor the execution of plans and make adjustments when necessary, based on operational information acquired and processed with the shortest possible latency. Most recent technological advances in areas like Big Data, IoT or Analytics, which are associated with technological development both at software and hardware levels, favour the acquisition and processing of massive volumes of data in (almost) real-time, facilitating the fast detection of deviations between the approved plan and what is actually happening at shop-floor level. Examples of situations that can cause deviations are: equipment malfunction, production hot lots, raw materials shortage, larger operations' execution and preparation times, tool failure, amongst others. These deviations may have a significant impact, and require adjustments to the approved plan, in order to reflect the new reality. This is possible through real-time scheduling methods that, using (near) real-time event acquisition from the manufacturing system, are able to detect deviations and quickly adjust the plan, optimising it once more to deal with recent changes.

➵ Adopt a distributed operation logic, where the planning and scheduling systems of distinct supply chain players are able to communicate amongst themselves, allowing for real-time definition of delivery dates and material availability from suppliers, as well as their selection during the planning stage. Real-time scheduling may also take advantage of this network enabling, for instance, the shifting of raw material orders from one supplier to another in the event of different delivery dates or stock shortage, favouring a faster decision-making.

➵ Incorporate, in the production plans, not only the manufacturing operations, but also the automation of internal and external logistics processes. For instance, the use of AGVs for transportation of work-in-progress, and tools necessary to the operations and the management of outsourcing operations logistics - with their lead times and scheduled visiting time windows. Concerning intelligent and integrated information systems, it is important to highlight the ability to implement a controlled visibility over outsourcing partners, in order to monitor the execution of operations and to evaluate their response capability correctly.

➵ Incorporate process optimisation, that is, optimisation of distribution routes, truckloads, material cutting (sheet, leather, foam, etc.) and energy consumption, together with the reduction of production costs.

➵ Optimise the use of human resources, their skills and preferences, at the planning level, enabling the correct assessment of their demand and preventing them, for instance, from performing excessively repetitive tasks.

[1] https://www.digitalistmag.com/finance/2019/10/24/what-is-the-intelligent-enterprise-why-does-it-matter-2-06201136/

Advanced Internal Logistics Systems

A reference IE model is Kyaia, a company from Paredes de Coura, where INESC TEC played a decisive role. The SmartSL 4.0 logistics system is one of the most advanced in terms of job-shop manufacturing systems management, i.e., in processes where a large number of different items are manufactured, normally in small quantities and following concrete client specifications. This technology led Kyaia to productivity gains and decreased response times, enabling the manufacturing of the models in 24 hours. The SmartSL 4.0 solution embodies advanced production balancing and sequencing algorithms, as well as graph operating sequences for efficient management of sewing and pre-sewing production lines. It allows for dynamic assignment of workstations, leading to an unlimited number of simultaneous models, distinct operation sequences, and the possibility to assign priorities to manufacturing orders, thus, enabling the manufacturing of small series, with shorter lead times. This management and decision-support system provides detailed information on all executed operations and calculates performance KPIs at the shop-floor level, in order to evaluate if targeted objectives are being fulfilled.

In conclusion

Concerning IEs, advanced technologies such as APS systems and flexible internal logistics systems (data-driven), when combined with best practices of agile and integrated business processes, result in more resilient, sustainable and profitable enterprises.