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Designing an AAC plant for high-volume, just in time and diverse panels production

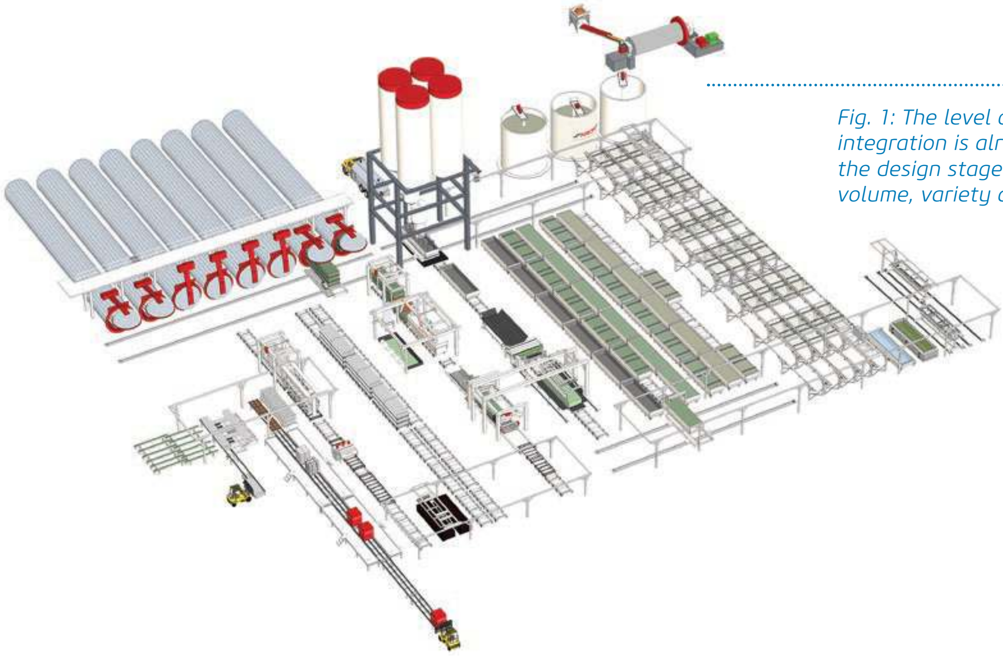

Fig. 1: The level of production flexibility and production integration is already balanced and incorporated at the design stage in an Aircrete Europe plant to achieve volume, variety and timing simultaneously.

"Time is money". This popular saying is especially true in the construction market, where every day counts in realizing construction projects. That's why more and more construction projects are turning to modular, prefab building solutions: it simply reduces complexity and saves time and therefore money. Autoclaved Aerated Concrete (AAC) elements such as wall panels, floor/roof panels, lintels, cladding panels and AAC boards are the key components of this new building system. Producing AAC panels requires a completely different mindset and approach of running a plant compared to producing AAC blocks. The main reason is that blocks are a high-volume product, where usually a maximum of one to two product changes are expected per shift, whereas in a dedicated panel plant every cake could require a product changeover, as panels are usually custom made. If the plant is not designed correctly from the outset, then this large product variety will cause a major production inefficiency.

Today there are only a very few facilities that can produce predictable, versatile and in high volume, "quality" panels under a single roof. However, it simply reduces complexity and saves time an increasing use of prefab building elements in construction projects, this topic is becoming very relevant.

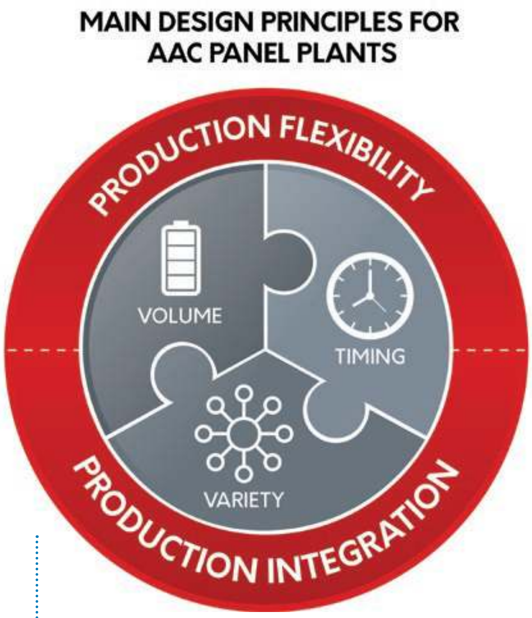

Fig. 2: Production flexibility and production integration should be in balance in every plant design.

Main Design Principles

Having worked on numerous panel plant designs, interacting with different specialist in building solutions, and simulating multiple production scenarios from raw materials to panel delivery, Aircrete Europe underlines two main principles that must be defined for each plant design: production flexibility and production integration (Fig. 1).
Production flexibility relates to the volume and product variety that can be realized while production integration incorporates automation solutions for internal and external communication with the production process. They should be in balance in every plant design (Fig. 2). The desired production scenarios must be pre-defined to achieve volume, variety and timing in the short and long-term operations of the plant. Daily plant operations must be aligned with the dynamics of the local resource supply, as well as the flexibility to adapt the changing demands of the local customers. Additionally, probable product development requirements and easy adoption to the new plant technologies in the future need to be taken into account for the long-term competitiveness of the plant (Fig. 3).

Production Flexibility

Production flexibility mainly depends on the variables of raw materials, labour, machine and routing flexibility with direct effect on volume and product variety. Within Aircrete Europe plants, the product

Fig. 3: Both short- and long-term factors need to be considered at the early stages of the plant design.

diversity, volume and timing are handled in such a way that the machinery is designed to be flexible in all production areas. The following section will provide a snap-shot view of these four variables with a few examples from real cases (Fig. 4).

Advanced reinforcement area

Plants with panel production capability need steel (on coil with different wire diameters or pre-welded as single mesh or as cage) which needs be supplied as an input (raw material) to the reinforcement area. Manual or semi-automatic handling within the reinforcement area is of course an option, however, this may cause bottlenecks in the operational processes against product diversity and large volume requirements. The technology and production process have to be adequately designed and thought through to allow for an (fully) automated area, which comes along with the following elements:

- Automated workstations from the steel coil all the way to mould
- Automated reinforcement frame configuration (needles)
- Automated reinforcement coating and drying system as well as needle cleaning and waxing system

All these areas are then controlled within the factory cycle through an integrated control system. This results with the configuration of the flexible mould size just before casting, mixing the exact cake volume needed for that specific mould size by the mixing tower, while the reinforcement area prepares steel reinforcement required precisely for this mould, all in a just-in-time principle (Fig. 5).

Unloading and packing area automation

The unloading and packing area can be another labour-intensive section that is likely to cause bottlenecks in the production cycle. Different types of panels with various dimensions need a labour flexibility where different product sizes arrive in variable sequences after each other, which require different ways of handling, sorting and packaging.
In Aircrete Europe plants, the machinery has been flexibly designed so that it can full-automatically handle packs of thin cladding panels as easily as large structural wall panels (Fig. 6). As a result, in terms of labour, there is no significant effect if, for example, 60 consecutive cakes of the same panel or a variety of cakes with different panel types are being unloaded and packed within this area.

Seamless adaptation to various panel dimensions

Consecutive casting and cutting of panels with different lengths is another issue that most plants

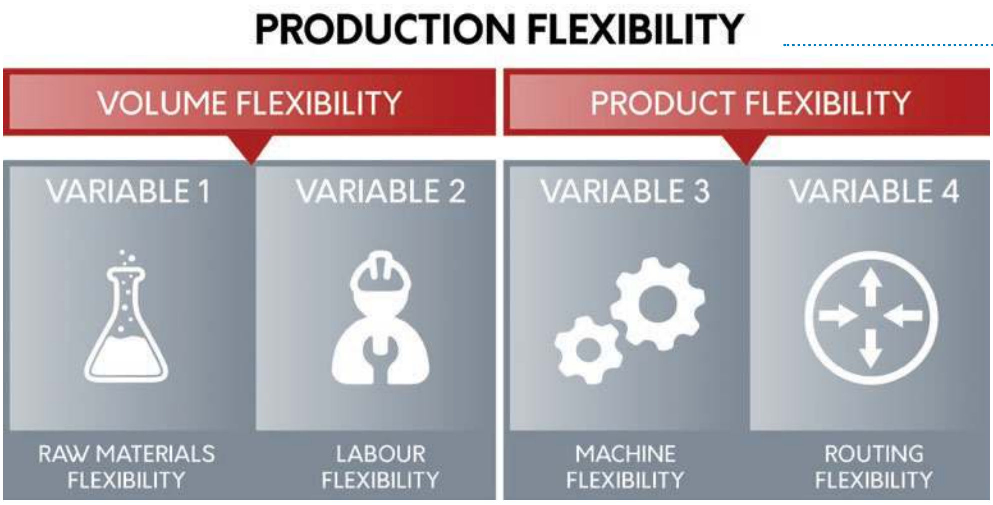

Fig. 4: Raw materials, labour, machine and routing flexibility have direct effects on production flexibility.

Fig. 5: A fully automatized reinforcement area brings in the desired flexibility level for product diversity and large volume requirements.

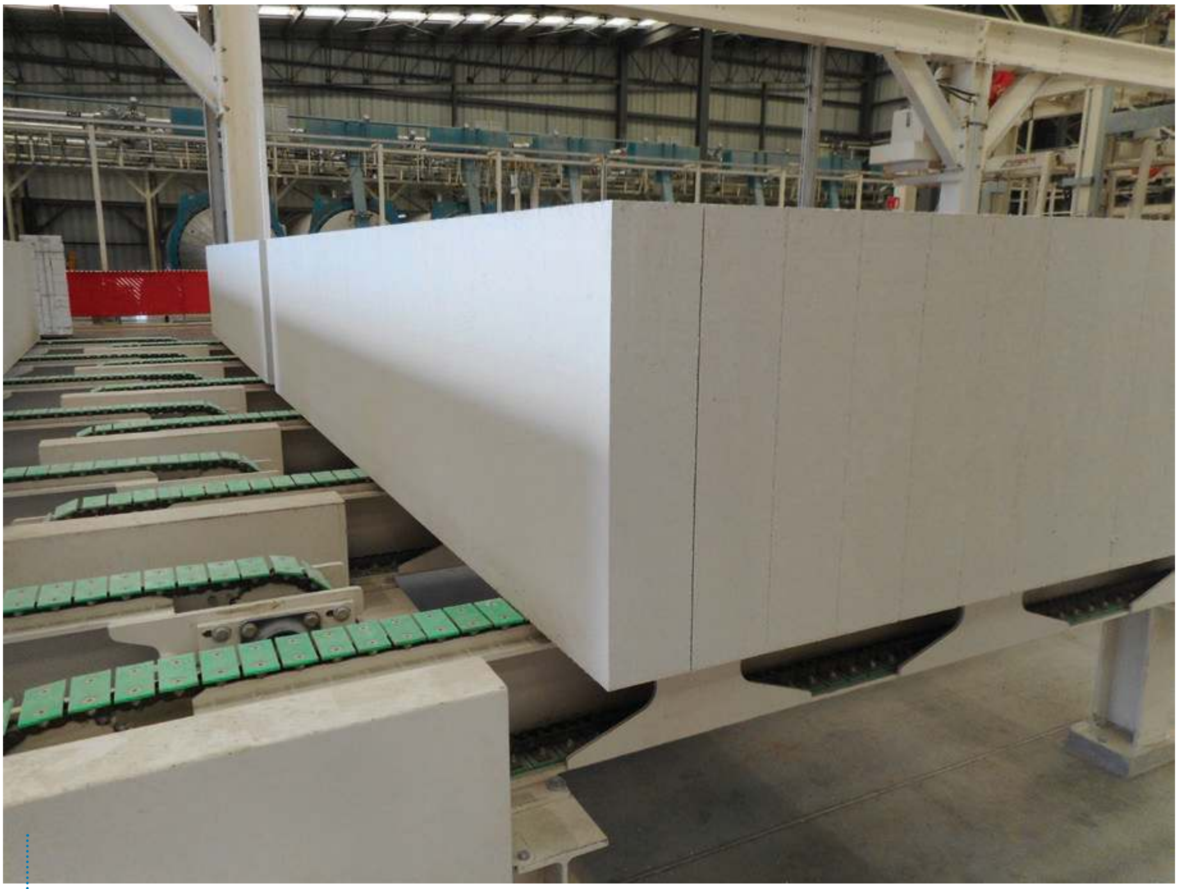

Fig. 6: The unloading and packing areas handle various dimensions of different AAC products with full automation.

face in practice. In most cases, capacity limitation and intensive manual intervention are the common driver of efficiency limitations. One alternative is to produce the rest of the cake with blocks. However, this is not an ideal solution, as the probability that these blocks will have a different dimension than the common dimensions in the respective market is quite high. Also, the profiling between the blocks and panels may be different and it is typical that a white waste layer is created between the panels and the blocks in the cake, to prevent cracking of the panels during autoclaving. The other alternative is to cast a shorter cake in the mould. Most of the current solutions in the market require a separate damming wall or movable back walls that are adjusted manually and are difficult to incorporate into the existing mould cleaning and oiling process.

The capability to cut the full cake for thinner products such as cladding panels, is also an issue to be addressed in many plants. The changeover times in cooking frame configuration plays an important role for cutting different thicknesses.
Aircrete Europe`s newest innovations allow for full-automatic adjustment of the mould length without using separate damming walls, whereby the moulds are cleaned and oiled in the open and flat orientation, which is one of the general advantages of the Aircrete mould compared to typical tilt-mould systems. Additionally, the cooking frame configuration is now saved on the control system, which enables automatic selection of the correct pre-configured frame for the corresponding product thickness. Furthermore, fully traceable moulds and frames are integrated within the plant control system (Fig. 7).

Routing solution for logistic handling lines

A typical block plant generally adopts the FIFO (first-in first-out) principle in circulations and logistic handling lines. However, this approach may bring along restrictions, especially in plants where product variety and ability to adapt to last-minute changes are important. The panel unloading lines can handle large volumes in theory, but in practice, incidents such as sorting of products or speciality products turn out to be a limitation. To address this issue, the products are automatically routed through specific paths to stay within the cycle times. More time-consuming products are transmitted to a different route (bypass) and can later be routed back to the main unloading line (Fig. 8).

Production Integration

Running a flexible panel plant requires timely production of a wide range of AAC products as per the orders received. Therefore, manual communication and reporting within the production process is not advisable. A high-level plant control system needs to be in place to ensure a flawless integration of all production areas on a single platform. These requirements include, but are not limited to, machinery control including RFID and barcode scanning for full traceability, automated control of production process and a supervisory control system with data acquisition for the reporting system. This integration ensures the flow of continuous production traceability through equipment and data upload to peripheral systems such as MES, ERP or CRM (Fig. 9). Such level of an integration is now achievable through one-sin-

Fig. 7: All the moulds within the Aircrete Europe plant are adjustable in length and they carry configuration information for each product type and are traced individually.

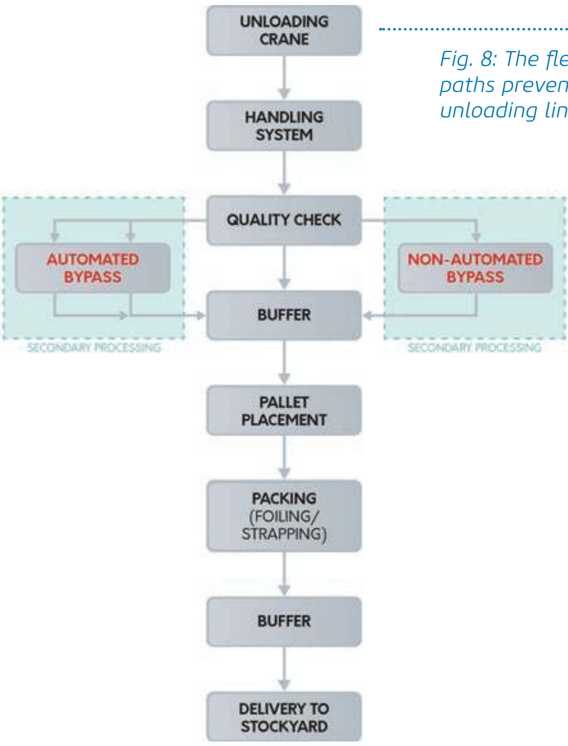

Fig. 8: The flexible routing to specific paths prevents the bottlenecks on the unloading line.

gle plant management system, developed in-house by Aircrete Europe. As every level of the production area is connected within the same platform, it is a very powerful tool for efficient AAC production with total command and control.

Conclusion: The Ideal AAC Panel Plant

The optimal AAC plant should be able to combine volume, variety and timing. This basically means producing high volume of panels, while having a variety of products in an optimal sequence for customer delivery is concurrently achievable. With decades of panel production experience, Aircrete Europe is very well-equipped with the right technology and know-how about what factors are important when designing such a panel plant and how to make it fit for the future.

A critical factor for success is to design the plant taking an overall cycle time into consideration under multiple production scenarios. The stages of casting, reinforcement, cutting, curing and unloading cycle times are not the same; each must be considered separately for different product types. Keeping this information in mind, multiple production scenarios need to be simulated, where each scenario has different volumes of product types and includes a different production sequence. Such simulations already provide a good insight into the plant`s capability. These outputs give further understanding in machinery and resources usage, pointing out possible bottlenecks and planning for optimal results.

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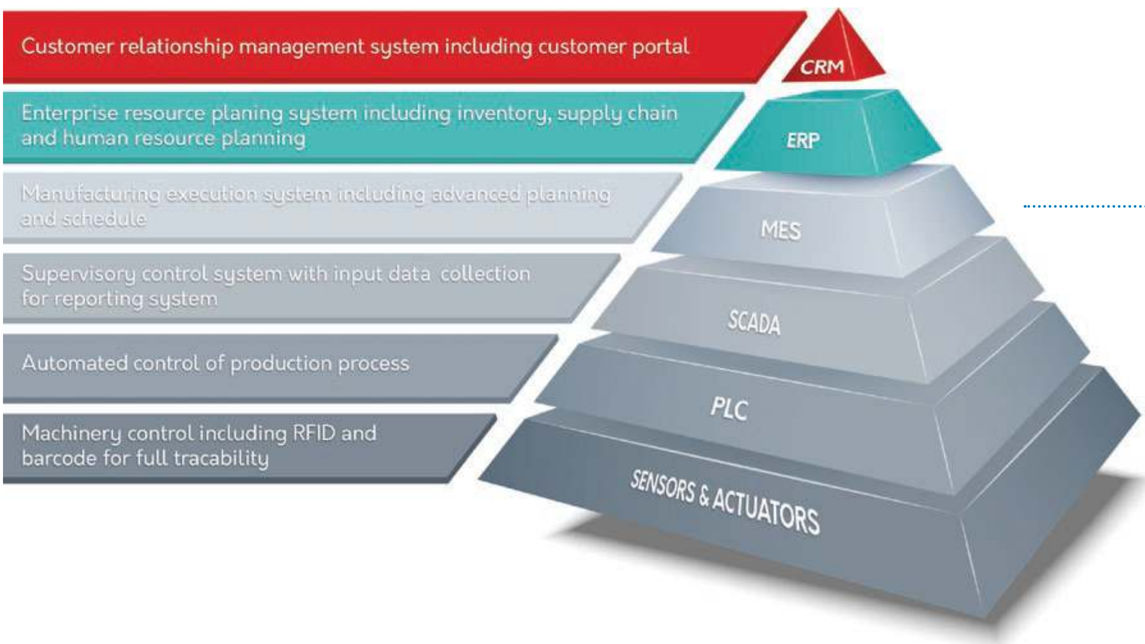

Fig. 9: Integration between the different levels of the control system is achieved through automation on a single platform.