Plant planning process

Involving specialist planners early in the process of plant modernization can save time and money, and improve plant efficiency

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The time frame for expanding or rebuilding an existing plant, or building a completely new one, is getting shorter. However, by using tools such as 3D planning, it is possible to design the planning process in a way that not only saves time but also reduces costs while increasing planning security.

To meet requirements for the production of a modern tire, producers need highly flexible and fully automatic rubber mixing plants. The mixing room is at the very start of a long process chain. To manufacture high-quality tires, good rubber must be produced at the beginning. Recipe accuracy, prevention of material loss and cross-contamination, process efficiency, availability, batch tracking, flexibility, setup times, space optimization, cleanliness, expandability – the list of requirements can be very long. Only an efficient planning process can set the foundation for meeting these requirements.

"The time between the decision to invest in a new plant or to modernize an existing one and the start of production should be as short as possible," says Guido Veit, business unit manager for plastics and rubber plants at plant specialist Zeppelin Systems.

In an investment, the time between budget release and construction approval, or between the final decision and the start of production – the moment from which money is earned and the investment begins to pay off – is crucial. This time to market can be reduced with the help of intelligent planning management. The more detailed the preliminary planning prior to construction approval, the more time can be saved.

Detailed preliminary planning

To achieve this, Zeppelin Systems has developed the Zeppelin Value Engineering concept. As it

Figure 1: Periodic modernization measures are nearly indispensable when it comes to decade-long efficient plant operation and incorporating trends into production

starts as early as the development phase, all relevant data that sets the basis for decision making is available at a very early stage.

"This data includes process flow diagrams of the complete plant, the installation planning and the energy requirements, but also costs, volumes and deadlines," Veit explains.

Preliminary planning without time constraints enables concepts to be refined and establishes the solid basis for extensive discussions and the optimization of the plant concept during the model review. In Zeppelin's experience this often leads to better concept solutions that are more efficient in operation and less expensive to realize.

The model review usually takes place during contract processing and not before – when only little space for concept optimization remains. The better and more thorough the planning at the beginning of the project, the greater the chances of shortening the execution phase. At least as important is that costs for possible modifications later on will also be reduced. That is why Zeppelin Systems no longer uses the sequential planning process. Instead, many planning steps are now performed in parallel, leading to considerable time savings.

Finally, clear planning enables the clarification of interfaces with suppliers and prevents coordination problems on the construction site. Many users also make use of Zeppelin standard planning for many other purposes such as audits, fire prevention planning, route calculation, ventilation and climate control planning, and service work.

The benefit of experience

With the help of various tools available to Zeppelin Systems, potential for cost and time savings can also be found in the individual process steps. Technical specifications of the plant are drawn up using front-end engineering design (FEED). This phase determines the efficiency of the plant as about 80% of the total costs for planning, construction and operation are determined at this stage. The result is a concept with all quantities, dimensions, parameters and processes, in which sufficient leeway is given for further plant optimization. Here, the main components have already been integrated in an overall layout plan. The planning basis is then established and the plant concept undergoes an optimization phase without actually being in operation.

Older plants

The expertise of a specialist in plant manufacturing is not only useful for planning new plants, but also in supporting companies in the tire industry when modernizing older plants. Various trends in tire recipes have recently led to a sharp increase

in the requirement profile of the tire mixture. Rubber processing must now meet the extended requirements of new raw materials such as silica, silanes and many other liquids, various chemicals and recycling materials. To do so, and ensure sustainable tire production, existing plants have to be modernized using the necessary equipment.

Modernizing an aged mixing room, however, is a challenge. Very often investments in mixing rooms have been put off because nobody dared take up the challenge, although older rubber plants hold the biggest cost-saving potential.

Major material losses and maintenance costs, as well as low efficiency, are the main cost drivers. The inability to integrate modern additives into the mixture and inadequate recipe accuracy and mixture reproducibility further aggravate the situation. Increased requirements on cleanliness in production and safety at work are also important factors to be taken into account.

Other examples show the challenges that can arise from plant alterations or expansion, and how complex individual process steps already are.

For instance, new technologies have recently been developed to keep up with the increasing amount of liquid additives and with other additional mixing requirements. "It's about how to integrate these new raw materials into existing plants," says Veit.

Figure 2: New development for future requirements: Zeppelin's modular multidosing system for feeding liquid additives can be integrated quickly and easily into the process (commissioning shown)

Zeppelin Systems made use of its long experience with liquid additives to develop a special system that is designed, produced and installed ready for use. The system's core component for liquid dosing is Zeppelin's in-house developed liquid scale for the preparation of plasticizers, oils, melted waxes and other liquid additives. The specially designed volumetric cylinder enables very precise, flexible and fast dosing of several liquids. The product temperature can be set up to 80°C.

The liquids to be dosed are stored in tanks or intermediate bulk containers where they will be fed into the dosing cylinder from a ring-main pipe with feed pump. The liquids are dosed quickly and accurately in a closed system. From the cylinder, the liquids are injected into the mixer without cross-contamination through several injection pipes and a special injection valve equipped with six connections. The liquid dosing system is supplied turnkey, including controls.

Another challenge is mixing room analysis and optimization. In a modern mixing room, raw materials with very different properties have to be incorporated at any time and in variable quantities into the process reliably, quickly, accurately, without losses and preferably in closed systems. They have to be dosed in compliance with the recipe, and be free of dust and contamination.

A modern feeding system automatically reacts to changes in conditions such as pressure, temperature and moisture, and changing raw materials and conveying distances, and ensures the supply of raw material into the mixing process, for example by using intelligent air quantity control for pneumatic conveying. Zeppelin delivers this system for raw material intake, storage and conveying technologies, weighing and dosing of rubber, carbon black, silica, fillers and liquids as well as other additives, chemicals, and even complete mixer feed systems from a single source.

Then there are production optimization and increased energy efficiency to consider. Expansions of existing plants are always a big challenge for planners and project leaders. A long-term shut-down is almost never possible. "It's often like open-heart surgery," says Veit. "There is only a short time to reconnect the plant and production should be impaired as little as possible."

The time window for integrating the new parts into the system is extremely small, so unplanned changes and adjustment work on site have to be reduced to a minimum. These are circumstances where it pays not only to have a well-prepared project with all appropriate methods and tools, but also to be able to rely on the support of experts in plant engineering should anything go wrong.

From a planning point of view, modernizing such highly complex plants holds other challenges, too. "We have often noticed that there is simply no useful documentation for existing plants. And when there are documents available, they are inaccurate or do not take the adjustments during the construction time into consideration or reflect other modifications made during plant operation time," Veit adds. "Furthermore, evaluating these documents, if available, is time-consuming and expensive. This is why document reviews are unfortunately not often performed during the planning phase of a plant modification, which may lead to expensive mistakes."

3D imaging

In Zeppelin's view, a decision not to modernize such a plant is a mistake. Nowadays, the planning process in highly complex existing plants can be improved with the help of innovative tools such as laser scanners that can create an accurate model of the plant.

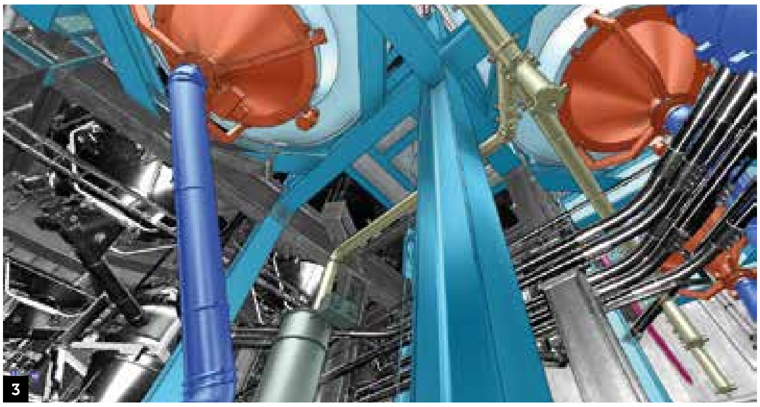
"This is helpful in cases where building alterations have not been recorded, data formats are not convertible, or drawings do not correspond to reality," Veit explains. Analyzing existing data would be costly and too inaccurate. Moreover, there is no proof that all modifications have been recorded.

Operators and plant engineering companies usually start from scratch when performing a current-state inventory, and use lasers and folding rulers to take a plant's measurements. Veit however sees this method as unlikely to lead to a successful modernization. If the time window for renovating or expanding is very small or the modifications themselves are very complex, all schedules can quickly become void. 3D laser scanning, on the other hand, can record all relevant plant details in a very short time.

For a few years now, Zeppelin Systems has relied on 3D laser scanning, a process normally used for planning buildings. A technical plant, however, is far more complex, so the scanned images have to be processed accordingly. First, the complete plant is scanned point by point with a 3D laser scanner to get the entire plant on file. Photographs of the plant or only parts of it can also be taken. Finally, the scans come together in a 'point cloud' and software converts them into a photorealistic 3D model.

Figure 3: State-of-the-art 3D scanning technology measures the current conditions (black and white) with millimeter precision and enables an exact design representation of the plant expansion (color)

Figure 4: Multistory 3D scan: a working platform is not necessary to take the measurements



Laser scanning is not only faster than traditional methods, but also displays all details and captures the complete plant. The planners get a very detailed and current 3D image. The data, however, will only be usable once the planner has extracted it from the point cloud and converted it for the desired planning tool.

The planner can then identify functional units and extract them from the overall plan. Only then can decisions be taken regarding the components that will remain in the old plant and those that will be disassembled during modernization. Informed decisions can also be taken regarding component priority when dealing with conflicts of objectives or component clashes.

With this 3D model of the steel structure, the components for the piping and plant optimizations, for example regarding accessibility for maintenance or service work and optimal use of space, can be elaborated quickly and reliably. Rebuilding a plant can therefore be planned accurately and performed with few production downtimes and a high level of security.

Zeppelin Systems has been active in the tire industry for nearly four decades and has been using 3D scans regularly for the past 10 years. However, the data and images produced by the 3D scanner only serve as a basis for reconstruction or expansion planning.

Zeppelin has invested a lot in the coordination of the various planning systems. Now, the planning departments only work with point clouds rather than with vector-based systems as in conventional CAD systems, as this is the only way to produce an intelligent model out of a raw scan. This model represents a fully integrated plant extension without interface problems, as little intrusion into the existing plant as possible, preventing component clashes and costly reconstruction during assembly.

Conclusion

Whether planning a new mixing room or modernizing an existing plant, Zeppelin believes it is a strong partner thanks to its planning competence and process knowledge. Involving specialists early in the process can save a lot of time and money. Approximately 80% of the construction costs are decided at the planning phase. Design flaws made at the beginning are nearly impossible to rectify later on and are very costly. Compared with a plant's total investment cost, a thorough preliminary planning is highly favorable and increases planning security considerably. It is also insurance against unpleasant surprises during execution. Detailed planning reduces a plant's construction costs, increases the operational efficiency of the plant, lowers maintenance and building costs, and leads to faster project completion. **tire**