WHITEPAPER

COSMO CONSULT
Business-Software für Menschen

Digital Disposition in Batch Production

REALIZE EFFICIENCY POTENTIAL WITH INTELLIGENT ERP

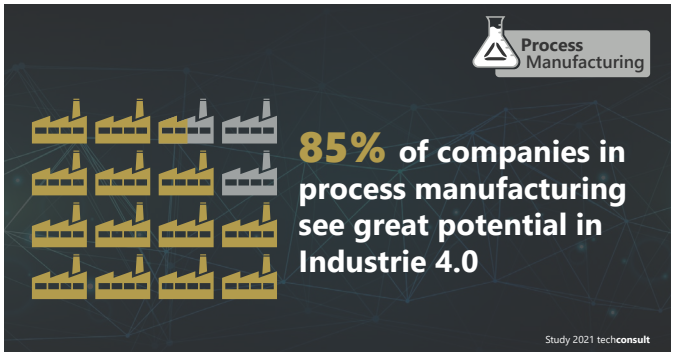
Customer focus means shorter delivery times, flexible reaction to change requests, and adherence to delivery schedules. That places many demands on scheduling in batch manufacturing. Approaches employing data analytics, machine learning, and AI are worthwhile to ensure ideal planning and control, and enable optimization of load and capacity. The White Paper illustrates where the relevant digital approaches – integrated into the ERP system – can help to realize efficiency potential and cut costs.

INTRODUCTION

The pressure is mounting: Batch manufacturers now regard complete, timely delivery to customers as their biggest challenge. This objective can conflict with a multitude of restrictions, regulatory requirements, and the necessity of minimizing costs along the entire value chain. There are many factors that make operational planning, and scheduling in particular, such a complex task.

And that is why scheduling is at the core of connectivity: Schedulers weigh up a range of requirements against one another, communicating with sales, production, warehouse, and logistics while also keeping an eye on the supply chain. They perform a multiplicity of tasks, including sales planning, material requirements planning, capacity planning, and procurement. They also have to focus on adherence to environmental regulations and the coordination of quality assurance processes, which is also often based on scarce resources. Testing and release in individual, intermediate steps also takes time that must be included in calculations. A failure to ensure neat synchronization of product and quality assurance can lead to rising costs.

The opportunities for digitalization also have an effect on customer expectations: There is an increased demand for short reaction times, and flexible reaction to late change requests is now an expectation. IT architecture moves into sharper focus as timely responses to customer requests and significant growth in market agility become more important for companies.



This is illustrated by an example of successful digitalization from a manufacturer of paints and coatings: Nowadays, individually customized products are delivered to customers with lead times of 24 hours (or less). If the customer specification – regarding shelf life, robustness, fluidity, or adhesion to various surfaces, for example – is received by 8:00, production must take place by 14:00 to ensure that the goods can be packaged quickly and delivered overnight. The required level of flexibility can only be achieved with sound modularization in paint systems, using base products to which supplementary properties are added. What this means for scheduling: Without the ability to receive a range of information about orders, inventories, and assets at the touch of a button, it is impossible to work at the speed required.

New structures are in demand

In general, it is not possible to achieve such a high level of agility and flexibility with traditional software systems. Instead of individual solutions, what is required is a service-based (cloud) architecture, in which services, in the form of intelligent assistants, play a role in each process step – to automate routine tasks, support the user in decision-making or to report issues. Companies no longer purchase a clearly delineated ERP or CRM solution, but arrange the services that they need around a data lake, which provides all the relevant data. Data therefore represents the central 'unit of currency' for various optimization measures.

Machine learning quick to deliver benefits

The IDG study "Machine Learning 2020" states that three quarters of the 406 companies contacted are already using machine learning applications or are introducing them. That is around 20% more than in the previous year. The authors conclude that ML pays off: Around 22% of projects realize immediate benefits, with a further 22% delivering these benefits after four to eight weeks. Around 70% of those surveyed said they had identified a positive impact within a few months of introducing an ML solution. That is an astonishingly short time frame for an IT solution. Mid-size companies in particular regard machine learning as a tool for optimizing customer orientation and customer service.

What many modern scheduling processes actually look like

The starting point for scheduling is always a requirement resulting from a customer order – or a sales estimation about which products will be particularly in demand in the near future. Requirements can also arise from provisions that are used to minimize risks in the value chain with corresponding reserves.

Some companies already use digital services to provide their data and calculations. For example, customer relationship management (CRM) delivers estimates about future sales to support sales planning. This is in turn derived from the sales history with forecasts. Ideally, enterprise resource planning (ERP) uses the sales plan and applies material requirements planning (MRP) to calculate which materials are to be used.

#All this information is consolidated into a specific requirement, which is then used to define what is actually required. In the next step, the material requirements are derived from the formulas or bills of material, and production orders are generated. The deadlines for the production orders initially result from due dates that are calculated by taking the estimated throughput times into account. However, restrictions such as the limited availability of resources and capacities are not taken into account in this scenario. In many small and mid-size companies, this is the latest point at which the scheduler assumes the task of coordinating the resources with the objective of meeting the upcoming deadlines. The scheduler is regularly confronted with the challenge of coordinating the often conflicting interests of the specialty departments, taking available resources into account. There can also be short-term order changes or rush orders that demand swift reaction: This is a Sisyphean task with many restrictions and dependencies, which demands a high level of experience and detailed knowledge.

Proactive checks and collaborative scheduling replacing traditional methods

A digital service that continuously generates forecasts, recognizes patterns in current delivery events, and validates the forecast in light of the current order position leads to increased reliability and less disruption in production and procurement: clearly, this simplifies and supports scheduling work.

Intelligent assistants are normally based on mathematical models: practical problems are formulated exactly in mathematical language to enable a mathematical solution to each problem. An example: In inventory optimization, models place critical influencing factors such as sales expectations, warehouse provisions, levels of service, or replenishment information in a mathematical context. The practical application of an instrument like this realizes significant overall cost reductions in the supply chain, thanks to simultaneous optimization of all key cost types. Intelligent assistants generally also lead to shorter runtimes: Flexible parameterization also enables shorter planning cycles and instant reaction to changes.

The focus is also on harvesting knowledge from much of the data collected over recent years. Central data hubs based on Microsoft Azure IoT, for example, allow you to analyze issues in monitoring and to solve these (automatically). The batch manufacturing of the future is characterized by collaborative scheduling, which is based on a consistent data model and extensively linked and automated applications. Effective, collaborative scheduling of this type merges data from multiple sources and provides it in a form that enables swift decision-making – in a cockpit that visualizes processes and key figures, for example.

Reaching such a high level of connectivity requires the availability and inclusion of many components: This includes data from production data collection (PDC), machine data collection (MDC), quality data collection, and logical data collection (traceability). There are further processes that have a timely effect on the production process. The necessary data must be managed and accessible. It is not generally possible to use raw data directly. Instead, the critical information must be filtered out to display the facts for analysis in the correct, accurate context.

Collaborative production management prevails

Ever more companies are engaging with the topic of CPM. A current market analysis from TMR Research for the period 2021 to 2028 comes to the conclusion that solutions for collaborative production management are gaining significant traction. According to the report, the major players are Abb, Honeywell, Aspen Technology, and Emerson Process Management.

The path to collaborative production management often proves to be a rocky one, especially for mid-size companies – even if the requirement levels are just as high as for large companies. SMEs normally do not choose a costly CPM system from one of the big players. However, there are some alternatives: these include open ERP, MES, and CRM architecture, in which Microsoft Azure IoT functions as the hub, including all modules and posting the relevant services depending on individual requirements. A simple example of this kind of cooperation would be a scales app. When material is delivered, the tanker truck drives over scales when entering and leaving. The data from the sensors on the scales are stored automatically in the system and provided to all applications for which this acquisition posting is relevant.

Predictive control: Recognize problems and fix them at an early stage

For the process industry, predictive control must be adjusted for batch manufacturing and for discrete manufacturing processes, which primarily play a part in packaging. Batch manufacturing typically has a limited depth of production for mid-size businesses. Initially, a preparation is manufactured and this can then be processed further, bottled, and packed. There is normally a manageable number of different raw materials and packaging materials. While there can easily be ten parallel lines in discrete manufacturing, many areas of the process industry typically use production islands that can be connected to one another for specific orders. Batch manufacturing is characterized by many reserves and redundancies. It is rare for all machines and systems to be in operation simultaneously. Therefore, it is not uncommon for 30% of capacity to be idle as this is not currently required for the optimal manufacturing process – this means that a large system may well be at a standstill when processing smaller orders.

An industrial real-time process based on a mathematical model, which can be applied to various manufacturing processes – whether in the cloud on on-premise – can be useful for the operation of a production landscape like this with optimal parameters and fast reaction to changes. Data analyses based on machine, system, and process data can contribute to process optimization and early recognition of problems. As soon as even minor anomalies are recognized, it is possible to control and adjust for this in the process, in real time – by adding more or less of a particular component, for example, or by reducing or raising the temperature in the vessel.

Applications related to predictive control are aware of the parameters for optimal production and can therefore perform real-time assessment of whether a process is developing unfavorably. Ideally, predictive control can be added to the existing ERP system as a service. Correct data is an important prerequisite: Data collection with corresponding criteria such as timestamps is required to allow analysis of developments along the time axis. Additional data is often required, which in turn demands the selection and implementation of suitable sensor technology.

Working experience reveals: for example, forecast systems that make use of past data about customer demand within the company can generate useful forecasts for the future if provided with an amount of data of a suitable quality. Wherever exceptions occur – when introducing completely new ranges, other procurement methods or new online shopping channels – it is also vital to learn quickly from new data that is collected.

Five steps to optimal quality with predictive control

The path to predictive control does not have to start with a Big Bang: a step-by-step approach is also possible – at a speed that suits day-to-day business. This five-level program is suitable for complex scheduling problems and gradually introduces more knowledge about and control of the process:

Step 1: All presumed influencing factors and the final quality must be entered reliably. Descriptive analytics asks: What has happened?

Step 2: Based on this, initial analyses can determine which parameters really are important and what influence these exert on quality. Diagnostic analytics asks: Why did something happen?

Step 3: A suitable forecast model is required in order to make predictions about quality in the future. A live forecast can then be displayed as an overview in smart monitoring. Predictive analytics asks: What will happen?

Step 4: It is vital to recognize when quality issues occur. The next step also requires knowledge of the countermeasures that are to be initiated. Corresponding guidelines demand comprehensive knowledge of the process. Prescriptive analytics asks: What do you have to do?

Step 5: This is the level at which extensive automation is achieved: A system that delivers guidelines becomes a system that automatically ensures optimal quality and keeps production stable. Predictive control combines analytics and action.

THESE APPROACHES TO OPTIMIZATION SUPPORT SCHEDULING

Many companies have been pursuing the aim of operational excellence for some time. Improvements in data usage mean that digitalization contributes to the ability of decision-makers in different fields to perform their tasks more effectively, thanks to reliable information: a powerful and crucial step towards excellence. This path includes a whole raft of data-driven approaches that contribute to process optimization and automation.

Coordination of batch sizes

The ideal batch size results from questions about costs and available resources, possible batch sizes, and deadlines – but answering these is a very complex procedure. Getting the batch size selection right can significantly reduce warehousing costs, for example. However, the question of how to achieve consistent quality also plays a role within batch manufacturing. Extra effort is required for homogenization if a product quantity of 5,000 kilograms is to be manufactured in 500-kilogram containers – this may be particularly efficient but the preparation must be manufactured in ten separate batches. In this case, intelligent analytics also involves weighing up any number of different factors against one another to achieve a better result. Various parameters in optimization models like purchasing, production, or warehousing costs may vary depending on the location. Procedures related to machine learning or deep learning / AI are selected with a view to the individual challenge and the data pool for the company.

Simulation is one of the most important responses wherever production must be adjusted ever more quickly to take customer orders and changes into account. More efficient production planning and control only becomes possible once the simulator has gone through the updated parameters and compared the results with past decisions. This is not just the case for batch size optimization, but also for strategic questions – after increasing warehouse capacity, for example, or regarding the necessity of purchasing new machines. Simulations require just a few minutes to run through various scenarios and make sound decisions. Batch size optimization is also an ideal first step for identifying savings potential with intelligent data usage and analysis.

Realize growth potential with AI and machine learning

The "Potential of Artificial Intelligence in Germany's Producing Sector," a survey commissioned by the German Federal Ministry for Economic Affairs and Energy, calculates that an additional 31.8 billion euros of gross value added between 2018 and 2023 is connected to the use of AI in the production sector in Germany. That corresponds to approximately one third of the entire growth within the production sector in Germany in that period. Unlike large enterprises, which tend to focus more on robotics and optimized resource management, SMEs see the key potential of AI in the areas of quality control and knowledge management. Improved data processing, especially in terms of efficiency, reliability, and integration, combined with machine learning in particular, thereby ensures continuous improvement of the qualities of products and services. The improvement in manufacturing leads to a lowering of the scrap rate and reduced inspection costs.

Surveying the entire supply chain

Production processes are normally part of complex supply chains: Holistic analysis of supply chains often reveals significant potential cost savings potential. The expenses for transport, distribution, or handling hazardous materials should also be included in network optimization to allow the greatest level of affordability and sustainability in planning.

Many decision-makers yearn for a transparent supply chain to allow them to react as quickly as possible to bottlenecks or breakdowns, thereby avoiding production downtimes. The assertion that interruption-free supply chains have a decisive effect on success has been increasingly subject to questioning in recent years. The coronavirus crisis has accelerated a trend that had already begun to emerge in some industries: shifting production back to regions that are not so far away, to reduce the risks associated with delivery delays or disruptions for your own production. In those areas where that is not possible, there is a growing need for early-warning systems in the supply chain. In this context, companies can now employ cheaper, simpler IoT tracking technology that uses sensor systems and radio. For example, if an important mineral must be imported from China or Australia, a tracking system should ideally show the current location of the shipment – to allow timely switching or rescheduling with inventories in other plants in case of delivery issues. Tracking also keeps search times in your own company to a minimum, as it is sometimes not easy to establish where a semi-finished product, a material, or a product is currently located.

Overview of production network optimization

To allow flexible rescheduling, a cockpit needs to visualize the primary requirements for the customer and the supply chain from the bottleneck perspective, as well as costs, inventory, deadlines, and resources. Of particular importance: an overview of reserves in the warehouse and in production. Connectivity lays the foundation for a planning process that anticipates stoppages or downtimes for individual assets and reschedules accordingly. If pipe couplings or flanges are equipped with sensors, problems such as leaks in these areas can also be included directly in planning.

Linked systems and software services, connecting all sides such as procurement, sales, customers, and quality with one another, are a prerequisite for this maximum level of transparency. Particularly with regard to data, they must be based on a single source of truth: Redundant data and inadequate data quality endanger the reliability of forecasts and can torpedo any efforts to establish transparency. That is why a high level of data format standardization is important, as is the case in an ERP system, for example. API-based communication and CPS technology should als be implemented for the interfaces. These allow individual systems to share information without breaking the chain of communication.

Optimize inventory, warehouse management, and intra logistics

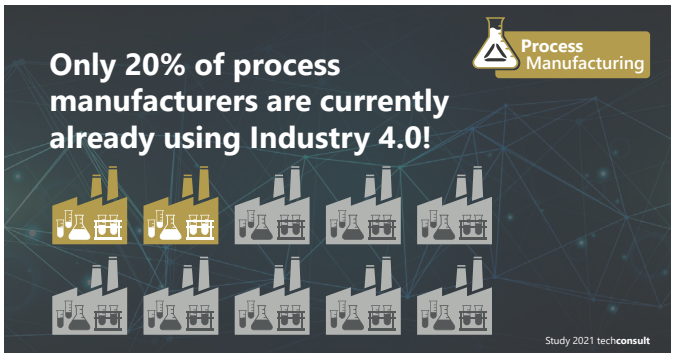
It is those industries that work with hazardous materials that should pay particular attention to the optimization of warehousing systems based on digital concepts. For example, algorithms can help to calculate the optimal route for transport systems such as forklifts, and combine transports in the most efficient way for various orders. In this way, transport orders can be distributed to individual resources, taking into account predefined general conditions, fulfilling all critical parameters and guaranteeing efficient use of resources. Within a system of this type, restrictions on the storage of hazardous materials can be applied automatically in certain areas, for example.

Data analytics is also suited to the improvement of requirements and inventory management. Automatic optimization processes draw conclusions from past inventory levels and their usage. This allows companies to achieve a reduction in safety stocks without an increase in out-of-stock situations.

Benefit from e-commerce and industry platforms

The platform economy is not just a factor in process industries. Sales platforms are becoming ever more important in the chemical industry in particular. The search platform developed by the start-up Chembid functions as a meta-search engine, forwarding queries to a large number of domain-specific search machines and delivering a uniform result. Suppliers must sometimes anticipate facing tougher competition, as purchasers can find and compare offerings here from providers around the world. Conversely, this means that the platform provides manufacturers and distributors of chemicals with the ability to increase their visibility – and often also helps them to generate new customers and boost sales of their products.

In addition to the integration of their own offerings on digital platforms, the topics of customer consulting and product configurators play an ever more important role. A major German specialty chemicals company already uses digital laboratory assistants for simple research using desired properties for coatings such as varnish. The language-based assistant enables access to information about raw materials, processing methods, and formulas, which would otherwise require painstaking work from experts on composition and testing. The corresponding topics also increasingly resonate in scheduling.



CONCLUSION

Only a few companies will initially be able to do without extensive connectivity and intelligent assistants related to data analytics. Linking the in-depth expertise of employees with algorithmic knowledge lays the foundation for efficient, automated reactions to situations: for example, by triggering predefined workflows as a response to stoppages or deviations from target measurement values. When based on a single, credible pool of information with real business factors, decision-making tools and forecasts facilitate profitability, flexibility, and organizational agility

COSMO CONSULT
Business-Software for People

TORSTEN HARNACK

Torsten Harnack is the industry manager responsible for process manufacturing and the further development of our solutions.

Just make an appointment with our industry experts.
We are pleased.

contactez@cosmoconsult.com

AUSTRIA | CHILE | CHINA | COLUMBIA | ECUADOR
FRANCE | GERMANY | HUNGARY | MEXICO | PANAMA
PERU | ROMANIA | SPAIN | SWEDEN | SWITZERLAND

www.fr.cosmoconsult.com