DIGITAL FACTORY ACCELERATION

Key challenges and recurrent production improvement opportunities for SMEs

September 2023

Preface

In the past few years, Danish manufacturers have shown a significant interest in the Industry 4.0 agenda – now part of every innovation strategy - with the ambition of building a competitive advantage by capitalizing on them.

Nevertheless, it is clear how small- and medium-sized production companies (SMEs) often need practical support when it comes to identifying digital innovation opportunities and translating them into actual production performance improvement.

The Digital Factory Acceleration (DFA) programme – a three-year programme designed and executed by FORCE Technology and Aalborg University and co-financed by Industriens Fond – aims at providing this support. To extend its reach beyond the 21 companies that have the chance to directly join its projects, the Digital Factory Acceleration programme includes a number of articles where we present the key learnings emerged through the programme.

This article presents the emerged patterns when it comes to strategic and operational challenges. These constitute the most recurrent production improvement opportunities that Danish production SMEs should pay attention to.

This article is part of the Digital Factory Acceleration programme, performed by FORCE Technology and Aalborg University and co-financed by Industriens Fond.

These learnings have been formalized in a peer-reviewed scientific paper *(Larsen, S. K., Colli, M., Hansen, A. K., & Stingl, V. (2023). Prioritizing Technology-Enabled Production Improvements in SMEs: An Interpretive Structural Model)*, published and presented at the 9th Changeable, Agile, Reconfigurable and Virtual Production Conference (CARV-MCPC-2023), at the University of Bologna, Italy, as well as at multiple university lectures (Aalborg University and VIA University College) and events (in collaboration with IDA, EGN, Rotary Club), where they have been discussed with academics, consultants and companies.

Strategic challenges for Danish SMEs

Although companies are different and have different sizes, products, financial situations and needs, through the Digital Factory Acceleration programme we could identify a few recurrent strategic and operational challenges they had to deal with in order to improve their production performance and become more competitive in the market.

When it comes to strategic challenges, we observed four main issues emerging during the different projects we have been performing across Denmark. These are:

- Lack of capacity
- Lack of traceability
- High dependability on specific people
- Employee satisfaction

Lack of capacity	Lack of traceability	High dependability on specific people	Employee satisfaction
The offer cannot match the demand, often because of low production efficiency	To satisfy the increasing demand for traceability implies production disturbances and consequent efficiency losses	Some activities can be performed by a few experts, and their knowledge is often implicit – a big risk in a period of generally high employee turnover	Data processing activities are increasing and are often performed by specialized technicians, which want and need to focus on actual production activities

Main strategic challenges in Danish production SMEs

Lack of capacity – In most cases, the demand that companies experience is higher than the production volume that they can supply to their customers. The companies are often aware of the fact that the cause is the lack of efficiency of their production systems, as their theoretical capacity is far from the actual capacity. From the experiences within the programme, this discrepancy has generally ranged between 20% and 50%, and has been caused by the presence of bottlenecks on the production floor. As Danish SMEs are characterized by low production volumes and high mix (i.e. many different products and a high level of customization), the bottlenecks are often "shifting": depending on the product that is being produced, the bottleneck concerns different processes. Nevertheless, part of the reasons that are causing a bottleneck are common for every single process: those are not related to the material processes, but to the information processing. For instance, when we have to collect information about what to assemble, how to do it or which components to pick in the warehouse, or when we have to register information about what we assembled on a piece of paper. These efficiency losses are often the most systematic, generating capacity losses in most production processes.

> ***"We know that the production system we have can produce significantly more, and we know that we are missing potential production capacity due to the time we lose dealing with information – or with the lack of information"***
>
> – GreenTec A/S

Lack of traceability – Most SMEs are experiencing an increasing demand for traceability from their customers. These might imply the need for tracking which raw material has been used for which batch of products (or even for which specific product), when the batch (or the specific product) has been produced, who has produced it, what was its carbon footprint, etc. In all the experienced cases, the companies were able to provide the requested information, but the resources spent to collect them were significant. This would make it impossible (or simply too expensive) to deal with the future demand for traceability, as this is scaling up rapidly due to customer demand and upcoming legislation.

> ***"To keep being highly competitive on the market, we need to answer the need for traceability that our large customers have. As the demand for traceability is increasing, we need to make sure we are efficient in collecting the necessary traceability information from our production floor and our IT systems"***
>
> – Dynamica Ropes A/S

High dependability on specific people – Some activities, such as production planning or specific quality inspections, are in many cases performed by one employee only, and they often entail implicit knowledge. This means that the successful execution of such activities depends on unstructured (and often even unwritten) knowledge that only that specific employee holds. This is not generating an immediate cost per se, but it is exposing a company to a significant risk: if the employee is unavailable, sick, on vacation, or resigns, the company will most likely experience a significant disruption in terms of efficiency in performing those activities and effectiveness of their outcome (e.g. it might take longer to perform that quality inspection, and still some quality issues might be undetected).

> ***"Today our production scheduling activities are performed using a very complex Excel sheet, which our main planner is continuously improving to increase the effectiveness of the production schedule. However, if the main planner is unavailable, we end up spending way more time for our scheduling activities, and the obtained schedule is not as effective as usual"***
>
> – Labflex A/S

Employee satisfaction – The increasing amount of information systems that are supporting different business processes in the company (e.g. CRM, ERP, MES, QA, CAD models, databases, etc.) entails a growing amount of data that need to be retrieved from-, transferred to- or registered into an information system. Many of these activities are performed manually, and frequently by specialized technicians which should allocate their time to the production activities they are specialized into and they are measured upon. In addition to a potential production capacity loss, this might generate frustration and lower employee satisfaction.

> ***"Today our specialized technicians have to spend a lot of time to look for information in different IT systems or to introduce data in one or more IT systems. This is not what they like to spend their time on – nor what generates value for them and for the company. Instead, they should be able to focus on production activities"***
>
> – LPM Production

Operational challenges and improvement opportunities

When it comes to the production floor, by analysing the operations of the companies that joined the Digital Factory Acceleration program we had the chance to observe challenges which were directly linked to the strategic challenges mentioned above. Although each company had diverse and highly specific operational challenges and production improvement opportunities, the following five were particularly recurrent.

Analogue order release

Order information is shared through printed paper sheets, which are usually printed by the production planner and either manually transported to the production floor's control room or to the production operators at the beginning of the day (or week), or are collected from the planning room by the production operators in the beginning of the day or once they have completed their tasks.

We observed that, in general, this caused an annual production capacity loss of 2-3% due to the time spent by the operators receiving or collecting the order papers, with the related reduction of the potential turnover of the company.

A common solution for addressing this issue is to consider the implementation of a MES (Manufacturing Execution System) linking the production schedule and the specific production order information – usually stored in the ERP system - to the production stations which will have to process the order, equipped with an HMI (Human-Machine Interface) to display the order information when needed, e.g. a tablet.

This removes the need for printing the order information and for manually collecting/delivering it to the production stations.

Manual order control

Data concerning the status of the orders while there are going through production, as well as the production performance, is manually collected. Usually, in every production station, one operator is manually registering information concerning the processing of every order (or product, or batch) in that station. This information is generally registered on paper (e.g. on the paper used for the “analogue order release”, see above) and often concerns the order number, the processing time, the operator (or the team) which has been working on that specific order in that specific station, and any eventual issues detected while working on the order.

We observed that, in average, this caused an annual production capacity loss of 4%, with the related reduction of the turnover of the company. In addition to that, as production processing information is collected on a huge amount of manually written paper sheets, often piling up next to each production station to be then collected all together in a larger pile in a planning room, this information is almost never used afterwards to analyse the production performance, to support after calculation activities or to assess the potential of contin-uous improvement projects.

A common solution to address both the capacity loss and the lack of “usable” transparency generated by this issue is to consider the implementation of a MES (Manufacturing Execution System) linking the production schedule and the specific production order information – usually stored in the ERP system - to the production stations processing the order, equipped with an HMI (Human-Machine Interface) to automatically or semi-automatically register the order being processed. This could entail a tablet showing the order being processed, where the operator could “check-in” and “check-out” the order, or a barcode scanner that the operator could use to do the same by scanning a barcode printed on every order information sheet.

This removes the need for manually writing the start and finish time of each order, the name of the operator processing it etc. In addition to that, this would also enable a real-time overview of the status of each order while in production, as well as a more efficient and consistent traceability for every production order, as processing information for every order would be collected digitally in a database, where they could be easily aggregated and analysed.

Lack of inventory management system

The tracking of the stock level is relying on manual inputs. This can entail manual activities such as noting down on a piece of paper the amount of material/components that has been taken from the stock on a specific day or for a specific order, collecting stock level changes information from papers or based on the released orders and the expected material usage for each order, introducing this information into an excel table on a daily basis, visually verifying the actual stock level before releasing orders due to the lack of trust in the data, and so on. In addition to these manual activities, the lack of real-time information concerning the available stock level and the "booked" stock level (i.e. the material that is still in stock but has been considered available for a production order that has been confirmed but not started yet) can cause the overbooking of some of the materials and the release of production orders that eventually the operators will not be able to complete – this generates a significant disturbance and a drop in the production efficiency.

We observed that, in average, this caused an annual production capacity loss of 2-3%, with the related reduction of the potential turnover of the company. In addition to that, it is important to consider that wrong, not trusted or not updated stock level data often lead to higher-than-needed stock levels or to lower-than-needed stock levels, with the related costs.

A common solution to these issues is the adoption of a Warehouse Management System (WMS) – as an independent software or as part of the company's ERP system, linked to the production scheduler and integrated into the production processes (and their MES) through the use of, for instance, barcodes positioned on each material and stock location, and barcode scanners used by the operators for registering when materials are deposited in a specific location (increasing its stock level) or picked up from a specific location (decreasing its stock level).

This is providing the ability to track stock level changes in real-time and, consequently, keep the stock level continuously updated, avoiding all the manual activities performed to keep track of it, as well as materials "overbooking" during the production planning activities.

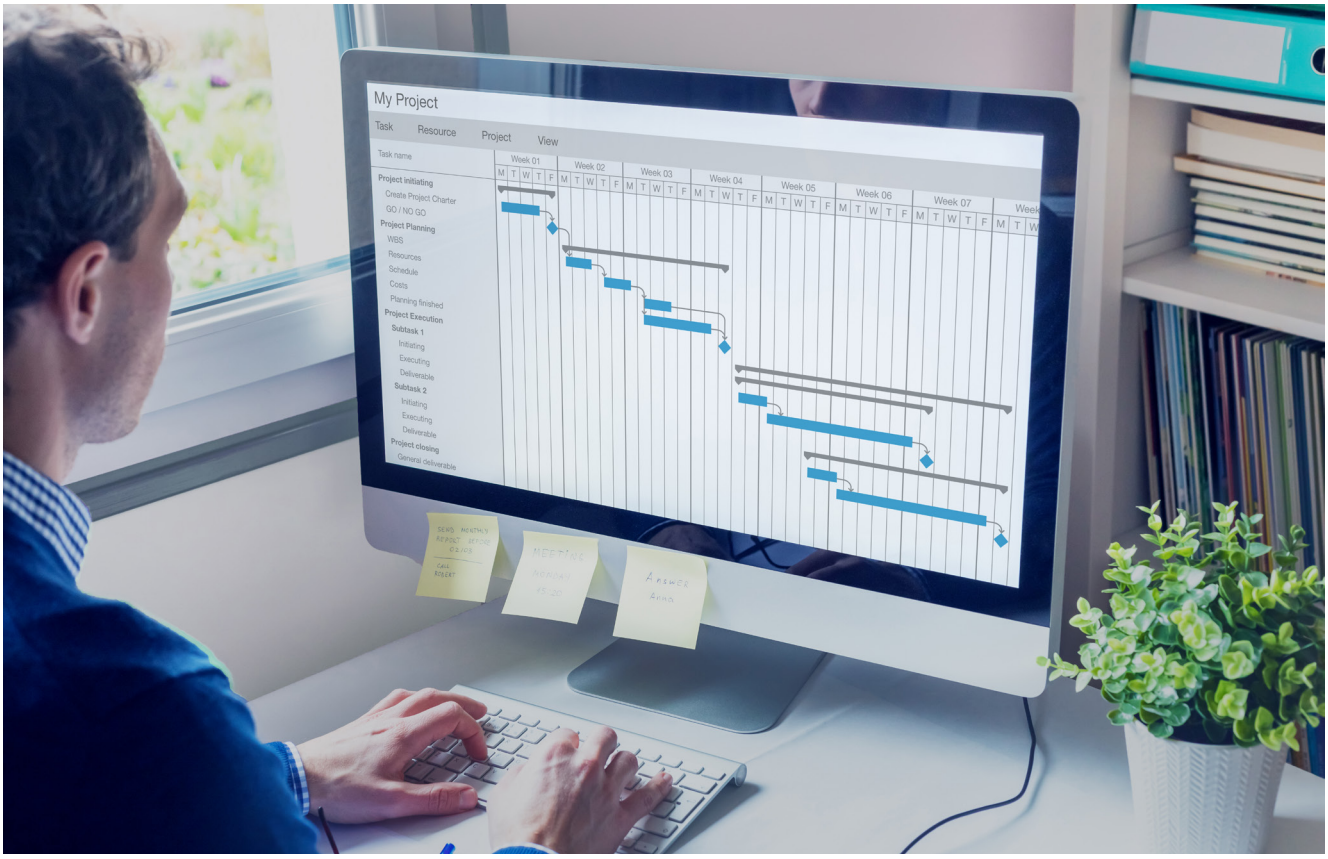
Manual planning and scheduling

Planning and scheduling activities are often performed manually. These are generally based on multiple inputs com-ing from different IT systems and, often, on the implicit knowledge of the responsible employee. In many cases, the production planners rely on Excel tables that have been (and are, on an ongoing basis) heavily customized, increasing the effectiveness of the obtained schedule but, at the same time, also increasing the complexity of the planning process. Because of this, companies that are performing planning and scheduling activities manually are often relying on the expertise - and availability - of one or few people. When these are not available (due to vacation, sickness, resignation, or any other reason), the efficiency of the planning processes as well as the effectiveness of the obtained schedule drops.

We observed that, usually, this is not directly causing significant and systematic production capacity losses, as production planning and scheduling activities are generally performed parallel to production activities. However, production planners are often overallocated, and the manual execution of planning activities such as the collection of order information, the pooling of similar orders and the matching between orders, delivery time and available capacity is on average costing 10-60% of the planner's time. In addition to the manual labour, relying on manual planning (and hence often on implicit knowledge developed by the planner regarding the use of complex self-made planning tables, optimal planning strategies or necessary conditions to take into account) entails a risk for the company, due to high dependability on the single planner.

A common solution is the adoption of a production scheduling tool, whether it is a module of the company's ERP system, or a separate software integrared with the company's ERP system.

By supporting the planner in its activities, this increases the efficiency of the production planning process (and often the effectiveness of the obtained production schedule), while structuring it and making it less dependent on its implicit knowledge, mitigating the related risk.

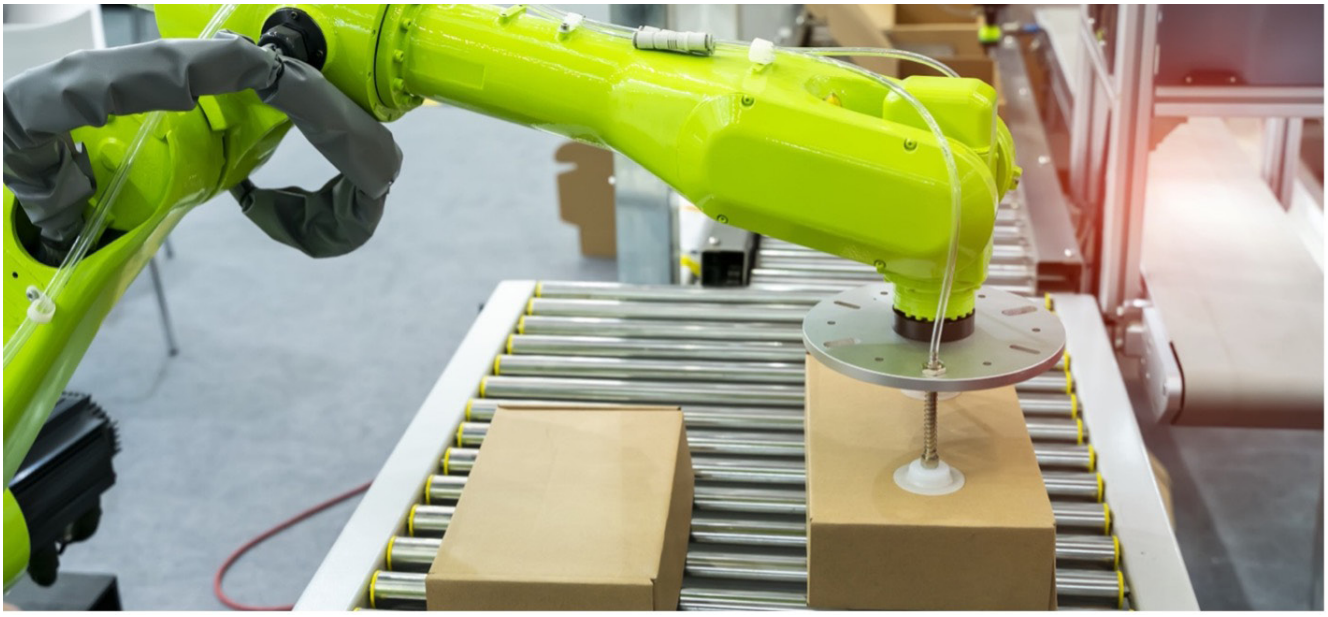


Manual production processes

Although automation has been the centre of the attention for production companies for many years, several repetitive activities are still manually performed. These can be highly production specific (for instance the cable stripping activities that we observed at Mikkelsen Electronics) or very common for different companies producing completely different products (for instance palletizing/depalletizing or loading/unloading activities). In both cases, this entails manual labor cost for activities that - given their repetitive nature - might be worthwhile (when possible) to automate, especially when the production volume is high and the level of customization is low. In addition to the manual labor cost, the lack of automation around repetitive process can cause a production capacity loss (i.e. when the process is a bottleneck and the manual process is slower than the automated process) and overstress the employees, constantly under pressure for performing a repetitive process at high speed.

In fact, in addition to the manual labour cost reduction potentials, we observed that in several cases, the lack of automation of repetitive production processes was related to a bottleneck activity. In these cases, this was generating a 10-50% potential loss of production capacity and of the related potential turnover.

Solutions - and their cost - can vary highly, depending on the process to automate, and are not always technologically feasible or economically viable. The quantification of the potentials – whether related to manual labour cost reduction or capacity increase - for the specific case is therefore fundamental.



Analogue order release

Problem: Paper-based sharing of order information across production

Average observed impact: 2-3% of production capacity and related potential turnover

Proposed solution: MES linking production order information in the ERP system to relevant production stations through HMI, such as tablet

Manual order control

Problem: Manual collection of data concerning production performance and order status (i.e., registration on paper)

Average observed impact: 4% of production capacity and related potential turnover and lack of transparency and traceability

Proposed solution: MES linking production order information in the ERP system to production stations through an HMI or barcode scanners to “check” the order in and out

Lack of inventory management system

Problem: Manual verification and registration of stock levels

Average observed impact: 2-3% production capacity and related potential turnover, and risk of high/low stock levels with related costs

Proposed solution: Warehouse management system or module integrated with MES and ERP system with, e.g., barcode scanners for registering stock in and out

Manual planning and scheduling

Problem: Planning performed manually using, e.g., Excel and relying on the expertise of one or few people

Observed impact: 0.1-0.6 FTE- High manual labour cost and risk due to high dependability on the presence of one or few employees

Proposed solution: Production scheduling software or scheduling module in the ERP system

Manual production processes

Problem: Low level of automation for repetitive processes (e.g., loading and unloading)

Average observed impact:10-50% of production capacity and related potential turnover – less frequent today and higher investments required – or high manual labour cost

Proposed solution: Automation solutions (e.g., industrial robots, collaborative robots etc.)

Main operational challenges in Danish production SMEs

What to do with these learnings

These were the most recurrent – and in some cases the most relevant – challenges and improvement opportunities we identified through multiple projects performed within the Digital Factory Acceleration programme. To aggregate them and present them in this article helps providing a hint of what is their impact on production performance. Nevertheless, while working with the specific cases, we could see that the same challenge could have different implications on production performance and, ultimately, on the business of that specific company. When considering these challenges and improvement opportunities, it is therefore fundamental to assess both their presence as well as their impact in the specific case.

Are these the biggest challenges and improvement opportunities for every production company? No.

Are these all the challenges and improvement opportunities that digitalization can address? Absolutely not.

But these challenges and improvement opportunities emerged so often that they are providing us with a clear and tangible overview of the current digital maturity of the production floor in Danish SMEs, and of what is often needed to lift it and improve the performance of that production floor. In other words, these learnings represent a good “standard map” for production SMEs that are searching for possible digitalization opportunities on their production floor, and do not know where to start from.

The suggestion is to take these recurrent challenges as a starting point when you are looking at your production floor and thinking about how to improve its performance using digitalization. If you are part of a Danish small- and medium-sized production company, there is a good chance that some of them will prove to be relevant.

About the programme

The Digital Factory Acceleration (DFA) is a three-year program, aiming at supporting Danish small- and medium-sized production companies (SMEs) improving their production performance through digital innovation.

The programme consists of two phases: the Digital Factory Mapping phase – focused on identifying production improvement opportunities, quantifying their potentials and formulating an activity plan to capture them - and the Digital Factory Realization phase – focused on finding technology solutions to implement the activity plan and on coordinating the implementation activities if needed.

The programme is co-financed by Industriens Fond which is covering, for all the 21 companies joining it, 60% of the cost of the consultancy hours they receive from FORCE Technology consultants, while Aalborg University is responsible for translating the experience gained from the programme into generalizable knowledge to better understand and support digital innovation in SMEs.

If you are interested in joining the program as a small- and medium-sized Danish production company, you can contact Michele Colli (Head of Digital Production, mic@forcetechnology.com) or Jens Ulrich Nielsen (Chief Consultant, jeun@forcetechnology.com). If you are interested in including the Digital Factory Acceleration programme in an industry event, you can contact Iryna Møller (Administration, imo@forcetechnology.com) or Lennart Oleg Larsen (Head of Sales, lol@forcetechnology.com).

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