8760 Fastems

AUTOMATION GUIDE FOR EXISTING MACHINE TOOLS

The Great Why, What And How

Unleash the Potential Already on Your Shopfloor

Automating existing machine tools is no myth or scifi dream but a practice that Fastems has been doing for years with a clear bottom line: there are plenty of situations where automating your current machine tools pays off and there are ways to navigate through the necessary technical landscape around machine tool interfacing, table or chuck access and safety.

Automation is definitely not the privilege of new machine tool investments.

This guide is intended as an introduction and summary around the topic, covering

WHAT kind of automation options are available for automating existing machine tools?

WHY are manufacturers doing this – what are the reasons and benefits involved?

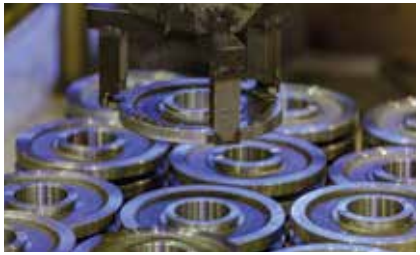
HOW to work things out in practice and succeed in the project?

The purpose of this guide is to help you to understand the opportunity in automating your existing machine tool(s) and whether this could be a solution for your shop floor challenges!

Benefits of automating existing machine tools







TYPICAL CHALLENGES INVOLVED

- How to unleash the unused capacity in existing machinery?
- Orders are coming in but the capacity of current machine tools is not enough - what to do?
- How to grow production output when there is no room for new machine tools?
- How to improve productivity in batch production? Especially from a ‘man-per-machine’ situation?
- What to do when aging or malfunctioning automation equipment pose a production risk?
- How to get knowledge on utilization or other KPIs around production machinery?
- How to find - and keep - skilled workforce?

1 - Should I Consider Automating My Existing Machine Tools?

The lack of production efficiency, skilled workforce or knowledge on the production KPIs are examples of the usual drivers behind the decision to automate existing machine tools. Automation is a cost-efficient and scalable solution for manufacturers from all industries producing even batch sizes of one.

CURRENT SITUATION

I need more production capacity - without investing in new machine tools

My current production capacity isn't enough: there are, or could be, more orders if I just could find the supply. Therefore, growing production output is the only option and I would like to begin by taking my current production machinery to full use. The approach of 'man+machine' is causing low utilization of resources meaning higher unit costs where I'd like to save as well. There could also be space limitations in my shop floor.

WITH AUTOMATION

More spindle hours and high floor-space efficiency

Automation rises spindle hours and production output significantly. This also means lower direct (operator) and indirect (e.g. proudction management) labor costs per piece. Furthermore, your people can work with ergonomic settings and in more meaningful jobs. The automation can also guide them towards right action and remove hassle with automated resource and production planning. Automation system can increase space utilization significantly by replacing machine tools and by storing raw materials and work-in-progress (WIP).

CURRENT SITUATION

I need to improve my production profitability, lead times, quality or employee engagement

The road of constant improvement is the only one for staying in business. Higher competitiviness also opens up opportunities for new business areas or customers. The main variables to look for deal with costs, output, lead times, quality and employee satisfaction.

WITH AUTOMATION

Automation is the key to develop your manufacturing business

Improving production key performance metrcs usually boils down to use of automation and digitalization. Even if capacity isn't the key driver, the current volumes can be supplied with much greater efficiency, more stable quality, faster and more reliable lead times and with more engaged people. Modular automation solutions also leave the future open for extensions when they are required.

CURRENT SITUATION

My current automation is malfunctioning or posing a business risk

My current automation system might be aging or otherwise malfunctioning. If the production is critical, so is the replacement of the automation. It can also be that the support or spare parts for current automation is no longer available.

WITH AUTOMATION

Updating automation saves your business

Having automation that works and that can be trusted makes a huge difference. No more business risk calculations or stress around what-if's.

CURRENT SITUATION

I want to have access to my production equipment stats and KPI

Understanding the true status and performance of production might not be easy as data might often not be available - or that it can't be trusted.

WITH AUTOMATION

To improve your need to measure and understand

Having an automation system to run the production can create on-the-go production metrics around machinery utilization or availability, NC-program statistics and the current status of your equipment. Further down the road are metrics like OEE or throughput.

2 - Categories of Automation

What would you like to automate?

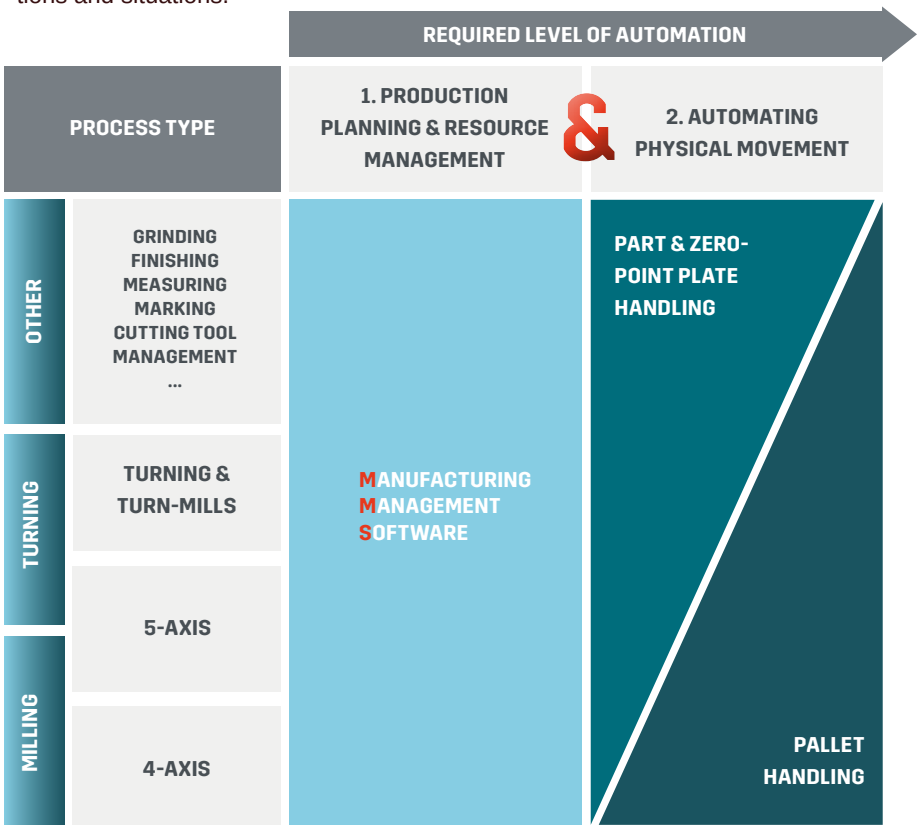
Production happens as an interplay between machinery, people and IT. They all need to work seamlessly together for the optimal results. When it comes to automating existing machine tools, there isn't only one right answer. This page reviews the available options and situations.

Levels of automation

Automated production planning and resource management calls for a software capable of turning production orders (e.g. from ERP) into a constantly-up-to-date plan on what should happen in the production and when. By managing the production resources (like raw materials, NC-programs and tools) the software can forecast any problems beforehand. It also guides the operators for right action at the right time.

With automation hardware, the system can also execute the planned production in practice. This happens by moving the machining pallets or by direct workpiece manipulation. In addition, the system can also manage the physical movement of tools and integration of supportive processes like deburring, washing, measuring, marking…

It's important to notice that production planning and resource management can be automated without using physical hardware, but greatest benefits are - naturally - achieved only when they are combined. This combination is at the heart of all Fastems' automation systems by the MMS control software.



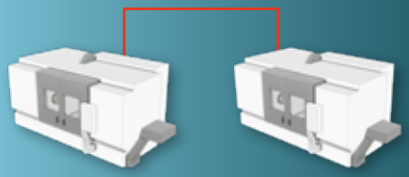
Automation solution depends on the shopfloor machinery and the desired automation level.

Situation on the shopfloor

Automation of current machine tools is not limited by the current situation and needs in the production. We have experience on automating fully stand-alone machines or ones that are already connected to some kind of automation system. Hybrids are also possible.

FULLY STAND-ALONE MACHINES

Fully stand-alone machines can be automated either in terms of physical movement or production planning.



MACHINE TOOLS IN EXISTING AUTOMATION SYSTEMS

Machine tools that are part of an existing automation system can be automated physically, with MMS control and 3rd party hardware or in terms of production planning only.

HYBRID OF FULLY STAND-ALONE MACHINES AND MACHINE TOOLS IN EXISTING AUTOMATION SYSTEMS

It is common for a factory with larger production and/or many machine tools to build a hybrid automation solution comprising of stand-alone machines and machine tools in existing systems.

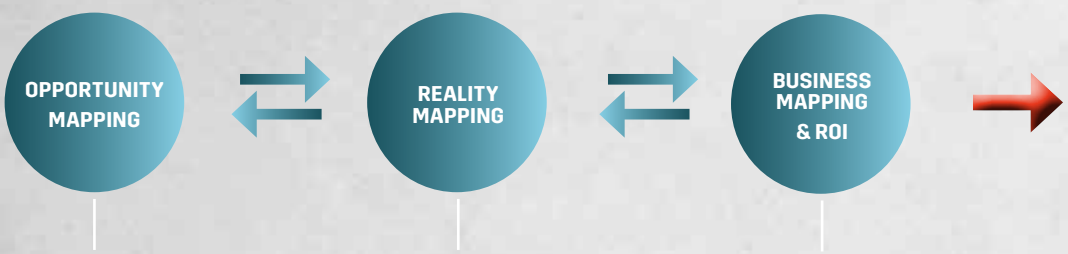
3 - Project Management

How to carry out a successful automation project for existing machine tools?

Based on our experience and delivered projects, it is necessary to first understand the situation and lay out all relevant facts on the table for a smart 'GO' or 'NO-GO' decision. This sets the realistic expectations towards what can be achieved and what could be the project pain points. We have therefore divided the project timeline into two: **the pre-study phase and the project phase.**

PRE-STUDY PHASE

Pre-study phase is a technical and one of the key parts of the project. The interfacing team, consisting of the automation supplier and MTB/Ds personnel, plays an important role in carrying out this phase: the expertise of the interfacing professionals is harnessed to study the possibilities of the current machinery to understand the technical feasibility and business case of the project.



Defining your dream state

What are the problems that need to be solved?

What are the benefits you are looking for?

Understanding the technical opportunities and limitations

How many machining centers? Their age? Interfacing options?

What level of production disturbance is acceptable?

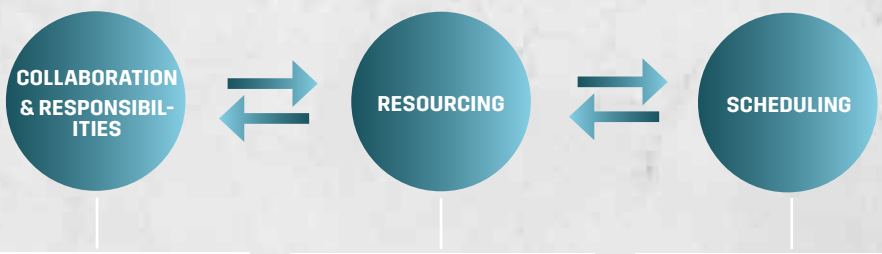
Evaluating the total opportunity

How much investment is needed in the detective work to figure out the requirements for interfacing and/or physical changes in the current machinery?

Does opportunity mapping vs. reality mapping make sense together? Is there ROI?

PROJECT PHASE

The project phase takes the results of the pre-study phase into action: it includes the alignment of plans with the production to e.g. minimize the possible disturbances; the actual implementation, and finally the ramp-up.



Agreeing on the role of the parties of the project

Agree on project total delivery responsibility.

Typical approaches are:
Automation supplier
Machine tool buider/ dealer
Manufacturer himself

Forming the team

Naming a dedicated team - consisting of individuals from all parties involved - to support throughout the project.

Planning the project

Understanding required production stop or disburbance: when, how long?

Project schedule makes visible the required inputs from different parties during the project, making the roles and responsibilities very visible for a realistic expectations and succesful delivery.

4 - Interfacing

Interfacing for existing machine tool automation is the core of the whole project, and in order for it to be successful, a close collaboration between the automation provider and the machine tool builder is required.

Is it possible to build a fully functioning interface on all existing machine tools?

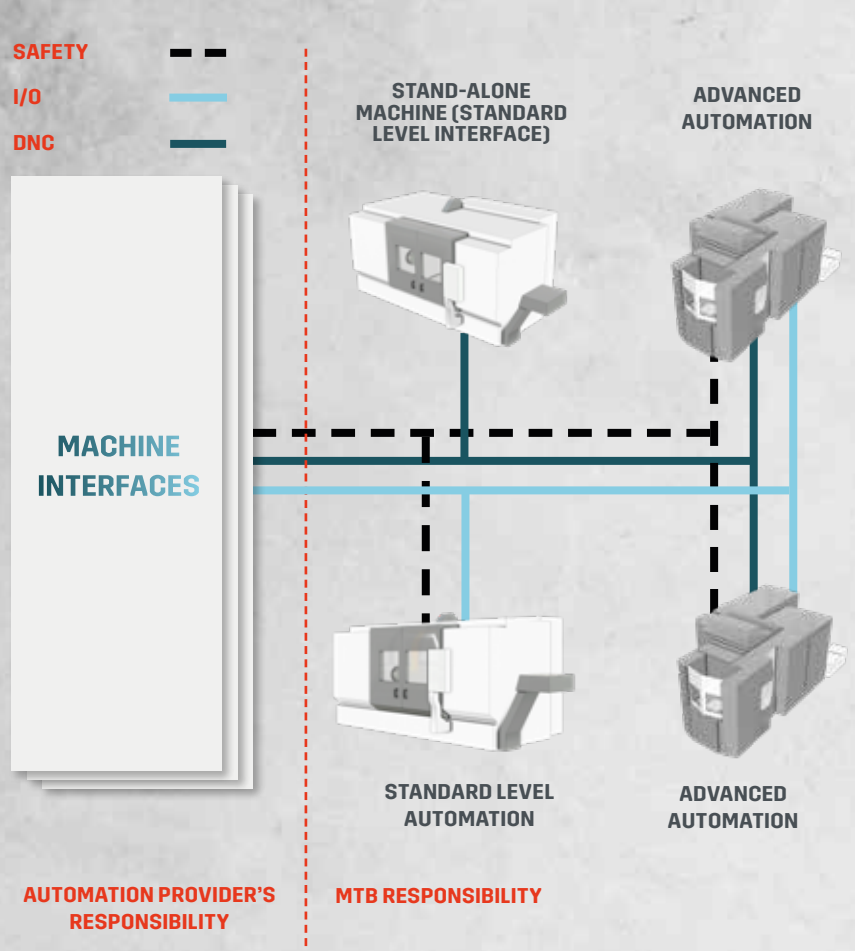
There are several factors to take into consideration when specifying the interfacing of an existing machine tool. For example, **the quantity and type of the machines, age and the controller and machine software versions** are factors notably affecting the way the actual interfacing is carried out.

Take an example: typical controls, such as Siemens or Heidenhein with the associated programmable logic controllers (PLC), have options for native interfacing, but usually this is not enough: to get to the necessary level, additional support from the machine tool builder is needed, and this usually comes with an extra cost by the MTB. The machine tool builder/dealer is always responsible for the alterations on the machine side as well as for the interface functionality of the machine.

The actual interfacing to a physical machine tool can utilize various technologies. Depending on the interface type, the actual interfacing can take place using a single technology or multiple technologies.

MACHINE TOOL INTERFACING CHECKLIST

- The name of the machine tool builder (MTB)
- Machine tool type and manufacture year
- NC Controller software version
- PLC Controller manufacturer, type and version
- Pallet changer, type
- Tool management system, magazine type and amount of tools
- Existing connectivity
  - IO/Fieldbus-, Ethernet-, Safety -interfaces
  - FM or robot interface
- The availability of the MTB/D support for possible machine modifications



MACHINE TOOL INTERFACING

Stand-alone machine (level 1)
Stand-alone machine(s) can be automated in terms of production planning and resource management. This can happen without any electrical/software interface, where operator reports ready works. It is also possible that I/O connection transfers machine status to the automation system. Programs can also be transferred with distributed numerical control (DNC).

Standard level automation (level 2)
Standard level automation enables automatic transfer of parts/pallets to/from the machine(s). Here, I/O connection also enables NC program selection and start. Safety interface is also necessary.

Advanced Automation (levels 3-4)
Advanced automation enables NC program and tool data transfers to and from the machine(s). Safety interface is also needed.

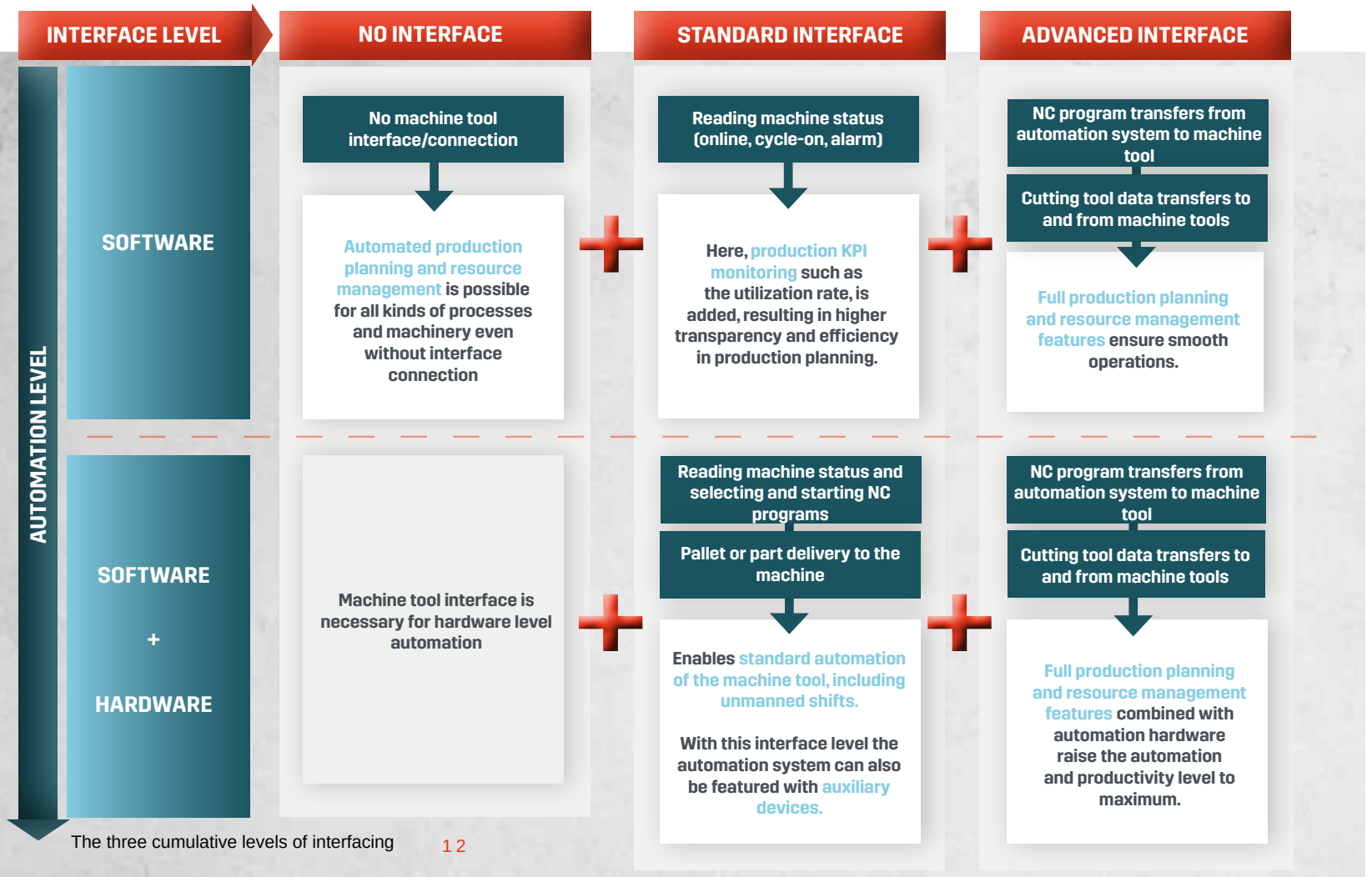
5 - Levels of Interfacing

The three levels of interfacing determine the scope of possible automation operations.

As explained earlier, automation is possible in two main categories of production planning and resource management and physical movements. Interfacing has naturally a different effects to the available automation options in both categories.

The effects are elaborated by the illustration below. On the horizontal level one can see the level of interfacing and on the vertical the level of automation, referencing to the above mentioned split in automation categories. Please note one automation system can feature machine tools with different interface levels. The levels are also cumulative in nature.

Even with no electric/software interface, it's possible to automate the production planning and resource management features - which can get more advanced by adding the levels to the interface. For physical automation, the interface is always necessary and it enables the production planning and resource management features on the advanced level.



The three cumulative levels of interfacing

NO INTERFACE

Even with no machine tool interface connection, an automation system can nevertheless guide the operators for right actions with production planning and resource management features.

STANDARD LEVEL INTERFACE

For physical automation, machine tool needs to provide the automation system with its status information and allow for NC-program select and start. Naturally, the physical access to machine table or chuck needs to be possible as well.

These three fundamental features enable the automation system to execute jobs with the machine tool while taking care of part/pallet movements.

ADVANCED INTERFACE

Here the automation system can introduce more proactive production planning features. This means e.g. pre-checking if the required tools in the magazines, providing the machine tools with the latest versions of required NC-programs or even suppling them with tool offsets from the presetter.

End result: fully optimized and automated production both in terms of production planning and physical movement.

6 - Interface Development

Machine tool interface delivery process consists of six detailed steps: collection of machine tool data; clarification of machine tool readiness; pre-study on hardware software and safety; interface definition with manufacturer and MTB/D resulting in interface specification; interface development, and pre-testing or simulating at the manufacturers site or at the MTB/D if needed.

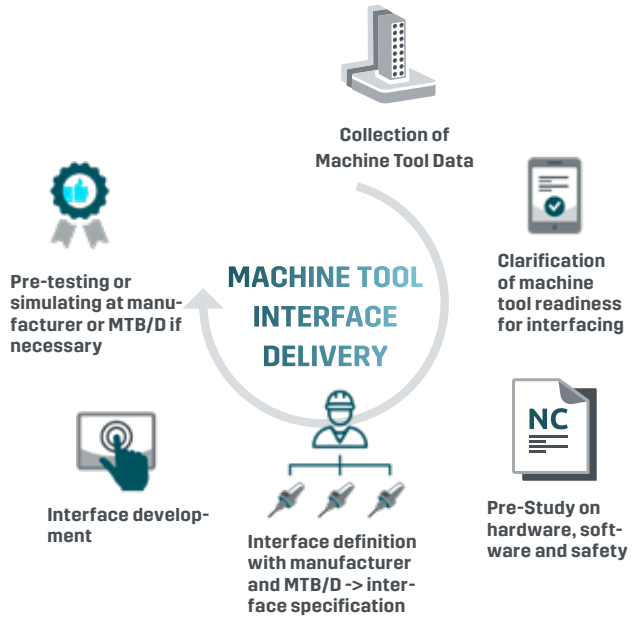
Collection of machine tool data and clarifying readiness for interfacing

The delivery process starts with collecting the needed data of the machine tool, including e.g. the machine tool brand and model, existing electrical and software connections in the machine tool (e.g. ethernet, IO bus type, safety IO interface), the type of the possible pallet changer (e.g. rotating, parallel, no changer), the amount of spindles for lathe machines safety functions in the machine interface (e.g. emergy stop and door open/close status safety signals).

Pre-study on hardware, software and safety

If the collection of machine tool data can not be obtained solely based on documentation and discussions, usually a pre-study will be carried out: a dedicated engineer is sent to the site to futher investigate the machine being automated.

Interface development process



Interface definition with machine tool builder/dealer

After carefully carrying out the first two phases, the additional software and hardware interface functions that are possibly missing from the existing set-up, are agreed upon with the machine tool builder or dealer.

The next step is to create an overall specification of the interface together with the manufacturer, automation supplier and the machine tool builder or dealer, resulting in a document that defines:

1. Features of the interface
2. IO signals and IO field bus type used in the interface
3. Ethernet interface (=DNC) functions
4. Safety IO signals required in the interface
5. Delivery responsibilities for both the interface software and hardware (automation provider / MTB/D). MTB/D is always responsible for all the modifications at the machine tool.

COMMON ASPECTS TO SOLVE BEFORE INTERFACE DELIVERY

- How to interface the machine tool to the automation system?
- Is it possible to update or expand the machine tool connectivity cost-efficiently?
- How do the age, controller and version of the machine tool affect the upgrade possibilities?
- Is the interface software configurable or an option at the machine tool?
- Is there a need for software modifications, such as APC or safety doors?
- Is there a need for electrical components for IO, Fieldbus, Ethernet, Safety solutions?
- Are any CNC and PLC software updates and development required to get to the desired level and features?
- Are the NC-program transfer and tool management options needed and available?

Interface development

The interface development is carried out by the automation provider and the the MTB/D based on the responsibility definitions documented in the earlier stage of the process.

On-site pre-test or simulation at the manufacturer's site

Depending on the complexity of the interface modifications, it can be agreed that the automation supplier visits the manufacturer or the machine tool builder's site for pre-testing with the actual machine. If the pre-testing is carried out, it is vital to have an interface developer by the MTB/D present. The person has to be capable of setting up the software of the machine and supporting during the pre-test.

Comissioning and SAT at the manufacturer

At this stage the machine(s) and the automation system are connected on the shopfloor. Testing that mechanical, electrical and software interface between machine(s) and the automation system function in correct way. An interface developer capable of setting up the software of the machine must be available from the machine tool builder to support during the commissioning.

Successful interfacing requires close collaboration between the manufacturer, automation provider and the machine tool builder or dealer.

7 - Physical Changes on The Machine Tool And System Safety

When automating, the physical changes to machine tools vary case by case. Relevant factors are for example, whether the machine is currently integrated to an automation system or if it has an automatic pallet changer (APC).

Changes to the programmable logic controller typically imply physical alterations to the machine tool as well. Here additional electronic hardware might be required as well, to transfer signals from automation system to the machine tool. For milling machines, an access to the pallet is required, whereas turning machines might need door automation, depending on the case.

System safety

One important aspect of automation is the overall safety of the integrated system, which is also regulated by regional norms and standards. In short, safety related matters are always a part of automation projects for existing machine tools.

The required safety level can be met either with existing safety features or by adding physical changes or connectivity to the machine tool(s).

With standard level interfacing without automation hardware, the machine itself is responsible for the safety features of its own. When introducing pallet or part handling automation, the system will be engineered to correspond to the applicable norms and regulations.

The automation provider defines the additional features and changes in the specifications, and the machine tool builder takes responsibility in adding the needed features to the machines.

THINGS TO CONSIDER

- When pallet or part handling automation is included, local regulations define the safety requirements on the system.
- Machine tool builder or dealer is always responsible for the physical changes made to the machine tools

8 - A Case Example: Kongsberg Automotive

Here's one example on what existing machine tool automation can mean in practice. Kongsberg Automotive automated five existing Makino a55s from 1990s with Fastems FMS ONE in 2018. Before the project, four of the machines where connected to an older FMS that was in great danger of breaking down. Running all of the five machines as stand-alone wasn't an option in terms of productivity.

Solution to the problem came from Fastems' FMS ONE. Kongsberg Automation chose Fastems as the automation provider since they had heard good feedback on the company and believed in Fastems' cabability of delivering such elaborate project. The solution was built in close collaboration with the Norwegian machine tool dealer **Kaspo Maskin**, who played a vital role in getting the interfacing right.

Even though the existing Makino FMS was breaking down with no spare parts available, the Makino machine tools still have many years in them. The plan is to replace them one by one when they meet the end of their roads, and therefore it was important to also consider the future when taking this first step towards higher productivity. Fastems' FMS ONE with its modern interfacing provides Kongsberg Automotive a solution for the future needs as well, since now it is easy to also replace the old machine tools in the future.

Interfacing was the thing that worried Kongsberg Automotive's Facility Manager Håvard Buan in the beginning of the project. An interfacing pre-study was carried out by Fastems and Kaspo on-site. Based on the pre-study results, clear interface specifications were agreed on, and it was decided that interfacing would be carried out on the standard level including features

The way the project was carried out enabled the factory to run without any major disturbances.

such as program starts/stops, status indications and safety features. When the machine tools are to be renewed, these features will be extended to advanced level, to cover e.g. the NC program transfers, tools check and ERP connectivity.

The way the project was carried out enabled the factory to run without any major disturbances: the implementation was done one-by-one, and it took in total 9 months from order intake to factory acceptance, including the 3-week installation period.

The easy-to-use MMS software and better access to the pallets in the loading stations have pleased the operators and increased work ergonomics significantly

+15-20% INCREASE IN OUTPUT

Thanks to FMS ONE, the output of the existing Makinos has increased 15-20% and the system is running virtually error-free.

HAPPY USERS

Fastems easy-to-use MMS' software and better access to the pallets in the loading stations have not only pleased the operators but also increased work ergonomics significantly.

FUTURE SCALABILITY

The modern interface enables easy replacement of the new machine tools replacing the old ones in the near future.

EASINESS IN RE-RUNNING PARTS

All pallets and fixtures are stored inside the system making work easier and more efficient, since ite is easy to re-run parts in only couple of minutes without any lengthy manual preparations.

Summary

This guide has summarized the opportunities, challenges and factors to take into account while automating your existing machine tools. We at Fastems have had many succcess stories in the domain and hope you've found the material useful.

We highly recommend you to asses your current situation using the perspectives discussed in this guide. With some preliminary ideas the next step is to contact an automation supplier such as Fastems to further define the parameters around the opportunity and on the shop floor realities. This way a sound decision on the project can be made. Machine tool builder or dealer need to be involved in the early stages as well.

▶ **To find out the estimated utilization rate of your production, visit fastems.com/utilization-test**

When done well, the results of flexible automation for business can be remarkable.

▶ **What are your production bottlenecks? How to find and measure them? Could they be solved with automation? We at Fastems are happy to help solve any productivity challenges: fastems.com/contact**

CHECKLIST FOR A SUCCESSFUL AUTOMATION PROJECT FOR YOUR EXISTING MACHINE TOOLS

Shopfloor situation

- [ ] Production key challenges
- [ ] Production development vision(s)
- [ ] Current automation level

Deciding on automation

- [ ] Opportunity mapping
- [ ] Reality mapping
- [ ] Business case (ROI)
- [ ] Project resourcing & planning

Interfacing

- [ ] The name of the machine tool builder (MTB)
- [ ] Machine tool type and manufacture year
- [ ] NC Controller software version
- [ ] PLC Controller manufacturer, type and version
- [ ] Pallet changer, type
- [ ] Tool management system, magazine type and amount of tools
- [ ] Existing connectivity
- [ ] IO/Fieldbus-, Ethernet- and Safety interfaces
- [ ] The availability of the MTB/D support for possible machine modifications

Interface Development

- [ ] Collection of machine tool information
- [ ] Clarification of machine tool readiness for interfacing
- [ ] Pre-study on hardware, software and safety
- [ ] Interface definition with manufacturer and MTB/D
- [ ] Interface development
- [ ] Pre-testing or simulating at manufacturer or MTB/D if necessary

Machinery

- [ ] Documentation on the machine models, age, quantity
- [ ] Investigation on the possibilities and restrictions of the current machinery
- [ ] Defininiton of the desired setup: automating stand-alone machines, machine tools in existing systems or having a hybrid entity of the two

Physical changes and safety

- [ ] Definition on the required safety features
- [ ] Definition on the required physical changes on the machine tool(s)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