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Modernization as a key to lower production costs

How to increase productivity and reduce production costs modernizing your legacy automation system

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In the everchanging marketplace both OEM and end users seek to lower production costs either as an argument to sell the machine itself or as an economical reason to improve productivity.
What is overseen in the efforts is the fact that the automation system plays an essential role in a machine. Modern automationsystems offer higher processing speeds than they were able years ago. Higher processing power leads typically to shorter response times. This reduces the amount of time the machine is an unproductive waiting state. Another side effect of higher processing power is an also increased accuracy,
which leads to a better product quality.

BuiltIn features offer the ability to identify problematic situations faster and solve them easier or avoid them at all. This benefits the end user as it benefits the OEM. As an OEM maintenance becomes easier and issues are being solved quicker. This delivers an argument for the OEMs machine to the end user. The end user benefits here from shorter downtimes leading to an increased productivity.
The following chapters describe steps to take and preparations to make modernizing your machines automation system boosting productivity.

Contents

Before a modernization of the legacy automation system can start, some preprations should be performed. The modernization itself is typically being split into sub steps described in this document.

How to increase productivity and reduce production costs modernizing your legacy automation system

Modernization

Overview

The first question and most important question to ask in such a situation is for the benefit a modernization offers to end users as well as for OEM. The answer has been partially given in the introduction to this document.

Further questions arise during the process of thinking about the modernization further. Those questions are typically circiling around the scope of the modernization, the involved resources and the methods and tools applied.

A modernization can be split typically into 3 major phases executing the modernization.

- Phase 1 – Preparationphase
  this phase contains most of clarifications required in order to get a clear picture of the existing legacy automation system, its interaction with other infrastructure as well as the application and technology itself.
- Phase 2 – Conversionphase
  starting with the translation of hardware components from the legacy system into the new automation system, this phase does most the work without interaction with the old machine. The software will be translated as well in this phase.
- Phase 3 – Installationphase
  in the last major phase the legacy system will be replaced with its modern version. This can take place during running production (hot migration) or more radical as a cold migration (aka rip'n'replace).

We at Siemens don't stop here at the modernized running machine. We thrive for the best experience you as our customer can have with this project. As we understand that the most important part is a producing machine, we understand the importance of trained personnel and up to date documentation as well.

Methods/ Tools

Your Siemens contact person follows certain principles in such a conversion project to avoid missing something essential. To support the modernization efforts Siemens developed tools and documents you can utilize. Each of the above mentioned phases has their own set of tools.

Some of them will be shortly introduced in the following chapters.

Preparationphase

Site Survey

A site survey typically follows a first contact. It serves the purpose of identifying all hardware components and their distinctive function. It also lists the used networks and fieldbus systems as well as the protocols. Interaction between other parts of the plant, such as predecessors and successors in a manufacturing line or to a upper level controller are also part of a site survey.
The tool which will be used by a Siemens engineer is a questionare. This way the engineer doesn't forget to ask for all the relvant information.

Scope Definition

A modernization can address a single individual machine, such an unwinder in a printing- or paper machine or a sealer in a bottle filling machine. It may also address the whole plant containing multiple machines.
In case of a single machine part modernization a single shutdown and recommissioning may be enough.
If the whole production line or the whole plant is in question a staged approach may actually make more sense. In the latter situation some machines may fill in a more critical role than others do. It could therefore create the most benefit replacing these critical machines first and others later.

Another aspect of the scope definition is the parts of the legacy system to be replaced. Under some circumstances replacing only the controller realizes the most benefits. Replacing only the periphery on the other hand may make sense as well and need to be evaluated on a case by case basis. The Siemens engineers gathered experience from past modernizations and are able to help finding the right approach for your modernization project.

Conversion

Hardware translation with optimization

A modernization includes in all the cases the replacement of hardware components of the legacy automation system. Whether it is the peripherysystem only or the only the controller or both doesn't matter. It always starts with the task of finding an appropriate replacement.

Technical specifications such as sensor signals and actuator interfaces need to be considered. However comparing numbers and crossing part number by part number is only the initial step. Considering the distinctive function of each of the hardware components in this particular application leads to further technical details to look at. It may even reveal possibilities to reduce the complexity of the legacy system by utilizing optimizations. Such an optimization can be realized for instance when the legacy control system doesn't have integrated fieldbus interfaces and requires therefore external interface modules. Modern control systems typically have at least one integrated fieldbussystem interface onboard. This eliminates at least one external interface module. Due the fact that modern fieldbussystems have a higher throughput they allow for more devices on the same fieldbus. Modern protocols allow for faster response times per device. Using such modern protocols, such as PROFINET, multiple fieldbussystems can be consolidated into a single system. This reduces the number of required modules further.

Fewer parts in the cabinet add reliability to the system, increasing availability and therefore productivity.

Siemens engineers keep an eye on those occasions to optimize the translated hardware layout with the functionality to modernize in mind. The hardware conversion is more than a mere 1:1 translation.

Software transcoding with optimization

Besidesthe hardware, the software driving the hardware is another key factor for a successful modernization. Understanding the original program from documentation and training materials helps realizing a proper code conversion. While a translation is again a mere 1:1 rewrite of the original program (line-by-line), Siemens engineers can help you determining program parts and code fragments subject for optimization. This includes eliminating segments, which are no longer required as well as optimizing non- performant coding practices up to adding beneficial features to achieve and extend the functionality of the original machinery.

As a starting point Siemens engineers have acces to tools allowing a quick 1:1 conversion into TIA Portal

Installation

Migration methods

The installation and recommissioning (restart) phase is typically considered the last phase of a modernization. With everything working out as expected this can be realized a short time. However there is always an inherent risk of faulty converted program parts or misselected hardware components. A mislanded wire from a sensor to a different channel could cause serious damage to the machinery.

With the great experience Siemens engineers have in past conversions, you can benefit from the methods and concepts developed over the years.

The following concepts proofed to be viable and applicable in certain scenarios:

- Hot migration
  this concept is being used in an application, where the process cannot be stopped for an extended period of

time. This is typically the cases where chemical or biological processes need to be controlled.
This migration process starts with the installation of the modern system side-by-side to the legacy system during operation. Sensorsignals will be landed (wired) in parallel to the modern system. Both system now see the sensor signals and calculate their decisions independently. Monitoring the actions of the modern system and comparing them to the actions taken by the legacy system detects misbehaviors. It improves therefore the trust into the correctness of the converted control software. After a while of parallel operation the modern system takes over control with the legacy system still in place and operable. This reduces the switchover time to a minimum, in case something is not right. Finally the legacy system can be dismounted giving finally space in the cabinets.

- Cold migration
  in a cold migration the machinery needs to be shutdown for a longer period of time. During this time the legacy system will be completely disassembled (ripped out) and the modern automations system will be installed (replace). Thus the name rip'n'replace. After that took place the modern system starts up the machinery. Beneficial to that approach is the relative short time and small footprint required during the modernization. Disadvantage is the missing fallback strategy compared to the hot migration.
- Warm migration
  this approach is a hybrid of the above mentioned methods. This method can employ a parallel installation of both the legacy and the modern system and a switchover at a certain point in time with a following disassembly of the legacy system. This approach increases footprint temporarily but decreases the downtime.

Any of the above methods can be combined with any of the other aspects for a modernization. The other aspects of modernizations are more scope related than the methodology for how to realize the restart of the machinery. They focus on what to modernize.

- Controller only
  replacing only the controller adds the most benefit to the modernization efforts, since it realizes shorter response time thus shorter production cycles through its higher processing speeds. It adds more detailed diagnostics to the machinery reducing downtimes and increasing productivity. On the other hand most of the costintense downtimes are caused by periphery modules not by the controller or fieldbus system.
  In these cases replacing the controller only saves time and adds benefits, but doesn't address an essential cost driver.
- Periphery only
  since most the cost intense down times are caused by periphery faults this approach may reduce the production costs more than replacing the controller. The downside to this approach is that the better diagnostics built in into modern controllers cannot be used. This leads in case of a failure to an extended timeconsumption locating the issue.

If the modernization has the complete machinery or the whole plant in focus, then you can realize the modernization all at once or staged over a longer period of time.

The all at once approach replaces the whole legacy automation system in a single step before it is being restarted again. It requires the full funds to be available, since partial modernized machines aren't operable.

The staged approach is easier on the budget, since in between the modernization stages the machine can continue to produce. This way expenses can be split multiple smaller parts. Here Siemens engineers follow typically one of the possible methods, where the machinery is being seen in a hierarchical structure. The controller(s) are the brains and are located at the top, while the periphery systems are located at the bottom of a drawing.

- Top-Down
  In this method the machine is being modernized piece by piece starting with the controller(s) and ending with the periphery systems connected through fieldbus systems.
- Bottom-Up
  This method starts with the lower part of the above mentioned representation, the periphery. Then the modernization follows upward all the way to the controller(s).

Here are also hybrids possible which may start modernizing at two ends of the representation (left and right or top and bottom). All in common is the fact that it depends on the application you want to modernize. Siemens engineers are happy to help you finding the right approach for you.

Documentation

Since you want your newly modernized machine to last long and fulfill the promise of increased productivity through shorter downtimes and shorter production cycles the documentation needs to be adopted to mirror the newly available features and functions. Only with an up to date documentation (technical drawings, manuals, etc.) the maintenance- and operation personnel is able to fully utilize the capabilities.

Siemens offers that adaptation as part of the migration services too, since we believe that documentation is essential for a successful and productive machine life.

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