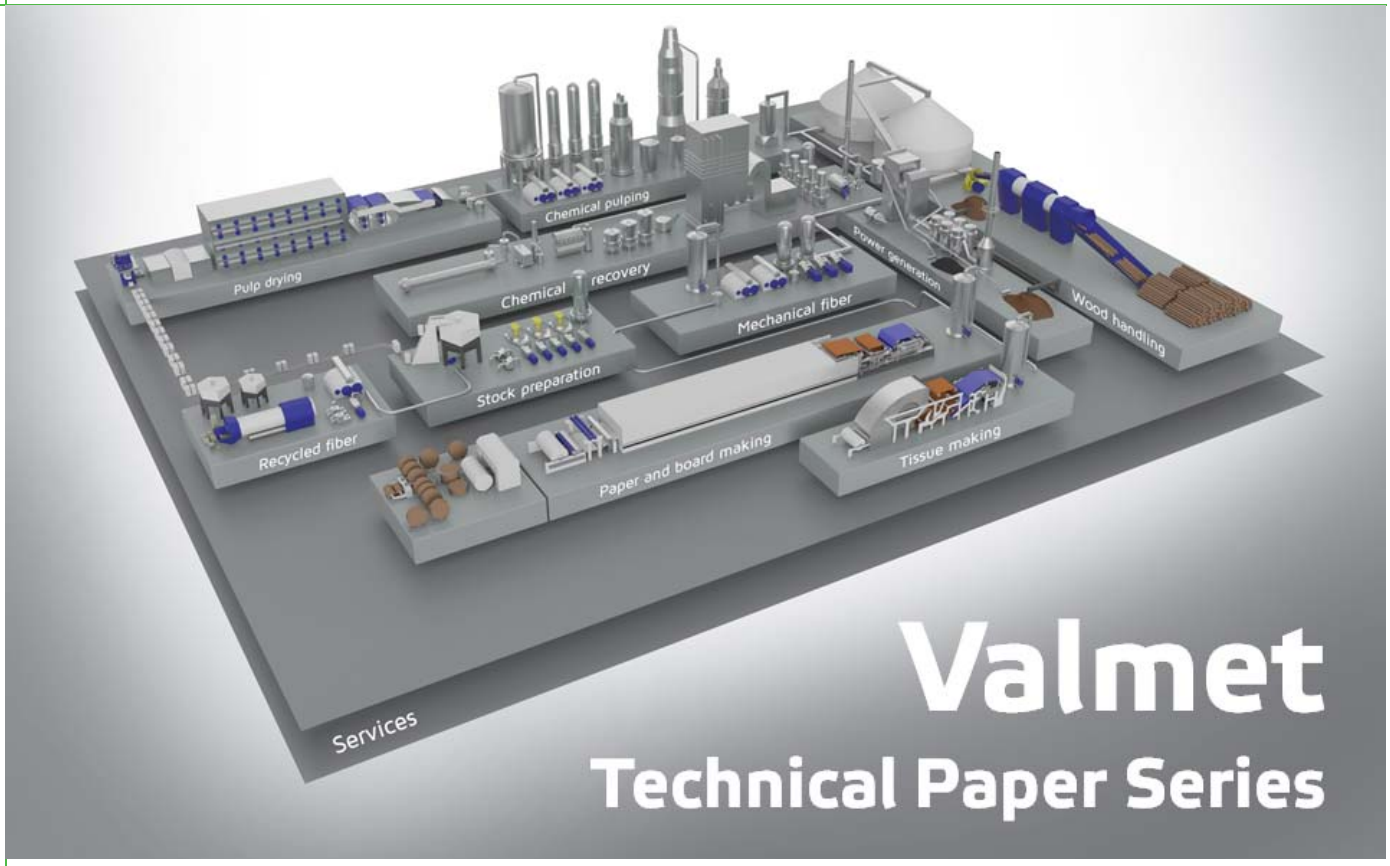

Controls Upgrades Reduce Risk

Executive Summary

Many machines currently operating are doing so with outdated components. The obsolescence of a programmable logic controller (PLC) is a situation that will have to be addressed at some point. Declining parts availability and lack of technical support will eventually cause a catastrophic unplanned downtime event. This risk is minimized or eliminated by upgrading to a modern PLC platform.

In addition, existing PLC systems may be at their capacity limit and can no longer add new controls to support additional quality or runnability improvements to the machine line. These systems may also be running antiquated automation and control algorithms that have since been replaced by safer, more accurate and more reliable control methods.

The white paper describes the methodology used by Valmet as part of a phased approach to a controls upgrade. The case studies in this white paper review replacement of obsolete systems such as Siemens S5 and Allen-Bradley PLC5, with varying project scopes, complexity and time frames. Additionally, a hydraulic example of obsolete valves is included to illustrate that PLCs aren't the only control hardware that deserves replacement.

Valmet is known for delivering reliable papermaking control systems with decades of innovation and leadership in both design and technology. However, today many existing machines, while running reliably, are equipped with outdated components. This is true for any brand of paper machine.

When a Programmable Logic Controller (PLC) vendor obsoletes their PLC family, spare parts are hard to get, and frequently only refurbished spares are available. If your PLC is a Simatic S5, Allen-Bradley (A-B) PLC5 or PLC2, General Electric Series 6 or 9070, or Reliance Automax – your equipment is obsolete and this issue must be addressed.

Why upgrade your PLCs?

The foremost reason for upgrading a PLC is obsolescence. Declining parts availability and lack of technical support will eventually cause a catastrophic unplanned downtime event. This risk is minimized or eliminated by upgrading to a modern PLC platform.

In addition, existing older PLC systems may no longer have the capacity to handle changes in the operating environment. Their input/output and program capacity may be functioning at or close to the maximum possible. This typically becomes apparent when planning to add new equipment, such as a shoe press or multi-nip online calender.

A Control System Upgrade is much more than getting a fancy new Human Machine Interface (HMI) or sleek benchboard. Over the years, Valmet has improved control methodology and algorithms and taken advantage of new sensors. This means that older installations will benefit from more up-to-date algorithms and technology that are now considered our standard for new installations. This will improve not only safety, but also reliability, accuracy and speed of process control.

Figure 1. Obsolete PLC models, such as this Siemens S5-150U, may cause unexpected downtime for the entire machine line.

How should the PLC upgrade be approached?

Dealing with an older PLC system can be handled a number of ways. Let's look at, for example, an older Siemens S5 system. One method of dealing with a PLC system undergoing obsolescence is to keep running it as long as possible. Due to the obsolescence of the original S5 equipment, replacement parts are becoming more expensive, and sometimes must be purchased in sets. If one card in the set fails, the entire set is worthless. Delivery times for obsolete PLC equipment are longer than for modern equipment. If the right part is not available, the machine may suffer unplanned downtime. The risk due to obsolescence is at its highest using this method.

Another way to handle PLC obsolescence involves upgrading in a hybrid manner. In this case, for a Siemens S5 system, the mill would keep the S5 input/output but install a new S7 CPU rack. The software would need to be converted or rewritten. In this case, the CPU hardware will now be much easier to acquire and replace, though the I/O is still performed using older, outdated cards. The mill's risk due to obsolescence is decreased. But already, it becomes apparent that rewriting code will be a requirement for any hope of overcoming obsolescence.

The third way to overcome obsolescence is an entire shift from the S5 platform to the S7 platform. In this case the mill purchases and installs equivalent Siemens S7 hardware and uses the Siemens program conversion tool to help convert their existing PLC software. Such a conversion tool exists for various PLC architectures, and, while not 100% accurate, it will still provide a major help in the software upgrade process. Additionally, termination wiring can be minimized by using S5-to-S7 I/O module adaptors.

These adaptors allow plugging in S5 terminated "swing arms" to an S7 I/O module without rewiring. With this method, the mills risk is minimized.

Finally, many mills are choosing a fourth option – that of replacing one PLC manufacturer's system with a different brand of PLC, one that matches other existing equipment in the mill. For example, a mill may have a lone Siemens PLC system being nursed along into obsolescence, surrounded by several modern Allen-Bradley PLC control systems. Their personnel may be more experienced with A-B controls and programming. Their spare parts inventory may already carry sufficient stock to meet any conceivable replacement need in a timely manner in order to avoid unplanned downtime. As a result, for many mills, this is the preferred method to upgrade their obsolete PLC system.

Figure 2. Parts are easily available for modern PLCs, such as this Allen-Bradley ControlLogix rack.

What other issues are there?

Once the decision to replace the hardware and rewrite the software is made, there are still many remaining questions. These include:

- What brand of PLC will existing mill personnel best be able to program and support?
- Will you want to do the reprogramming yourself, or rely on a trusted controls vendor that will work closely with you during the planning, prework and installation stages?
- Should the PLC upgrade be accomplished as an entire machine line single phase project (doubtful) or is a phased approach appropriate (typically recommended)?
- Will a replacement PLC actually be needed, or, since rewriting the code has been accepted as a necessity, perhaps locating the PLC control algorithms in another existing PLC will be a better use of computing capabilities?
- What combination of replacement CPU rack, local I/O racks and remote I/O racks will provide the best support for future controls growth needs, i.e. are their machine changes being discussed?
- Should redundant processors and CPU racks be installed, to allow hot switching as a support tool?
- Should the scope of the PLC upgrade also include more modern sensors for more accurate and controllable loading, speed, etc.?
- Should the control safety system be updated to today's standards?

And then we get to the question of centralization vs. de-centralization. Should the PLC and I/O racks be upgraded in their present cabinet locations, or should new racks be installed in the Motor Control Center (MCC) room and field cables run to the existing PLC, local I/O and remote I/O rack locations. The benefits of the centralized I/O approach are many, and include:

- The installation of the centralized MCC enclosures can be completed entirely before the planned shutdown.
- Commissioning of the system communications and I/O cabling to remote termination points is done before the shutdown.
- During the shutdown, only the existing I/O wiring from the terminal blocks to the I/O cards in existing cabinets would be removed and new cables re-terminated in their place.

- The shutdown can be shorter.
- The existing PLC I/O would be retained and not be decommissioned until it is completely obsolete.
- Hard wiring points to other I/O racks for a phased installation are not required.
- PLC hardware is located in a controlled environment.

Figure 3. This pre-assembled PLC cabinet (top), featuring Allen-Bradley ControlLogix PLC (bottom), controls a soft calender, and will be pre-installed in the mill's MCC room.

How does a PLC upgrade occur?

Upgrading a PLC system is specific to any given mill's situation, and greatly depends on what choices have been made according to the issues listed previously. However, a PLC upgrade will typically break down into planning, hardware, software and installation stages.

It is during the planning stage that the main questions are answered: what brand of PLC, centralized vs. de-centralized, complete or phased upgrade, etc. The hardware/engineering stage involves using new racks and/or reusing existing racks, rewiring, any special cabling requirements, etc. During the software phase Valmet will start with the mill's current PLC code, do the conversion and test at a Valmet office.

The installation stage will typically be split into prework and onsite steps. We can typically install new PLC cabinets early if the MCC allows for it. We may use available space in existing cabinets, or install new cabinets. Finally, during the actual shutdown all field cabling is disconnected, parts replaced, and cabling relabeled and re-terminated. Then all field I/O is tested.

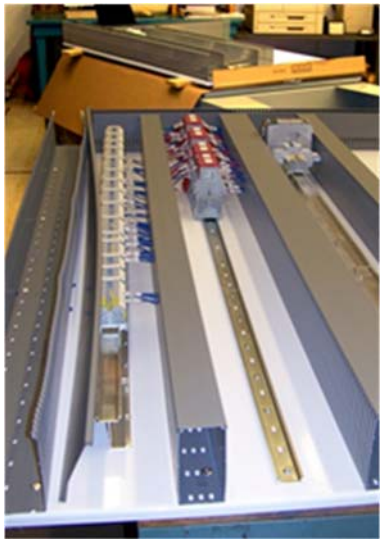

Figure 4. Two new PLC cabinets are being assembled in the Valmet workshop as part of the hardware engineering phase.

Why is Valmet your best choice for a PLC upgrade?

The biggest reason to choose Valmet is that we have a very good understanding of the overall process. Typically, a mill will have a hardware guy that knows hardware, and probably another engineer or maintenance person that can write and troubleshoot code. However, Valmet has been doing paper machine PLC automation since the 1980s. We've refined and improved the process in the 30 years since then.

Every time Valmet does a PLC upgrade, your mill is getting the very latest technology and controls methodology, specific to the needs of your mill. Valmet personnel do these all the time, i.e. multiple controls upgrades each year for each engineer. Think of this as similar to having a building contractor build your house vs. building it yourself. You certainly could do the job, but with an experienced

contractor, you can count on valuable experience to get the job done correctly and expeditiously. With the cost of machine downtime, you must take this into consideration. In addition, your mill is probably running shorthanded right now, and you don't have the available time and expertise to do it. Remember, converting a PLC for a simple non-automated piece of machinery may seem easy – but a highly automated winder … that's another story.

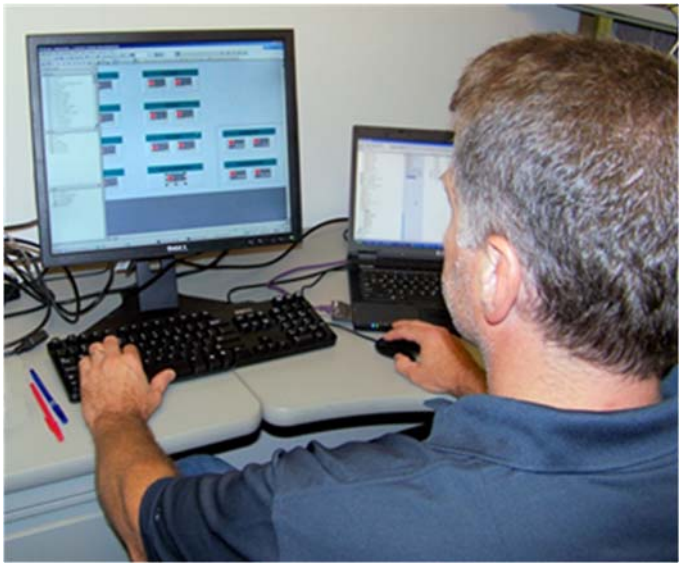

Figure 5. As part of a PLC upgrade, many mills opt to install modern HMI software. The engineer is shown here designing a custom-made operator interface for a high-speed winder.

As far as other outside automation providers, they may know winder logic, but they don't have an understanding of how the Valmet Slitter Positioning System, Valmet Winder Control System and Valmet Winder Help modules function. Nobody does automation as well as Valmet. On another OEM's machine section such as a winder, we would do a complete replacement of hardware and add our own automation. (As an example, in the 1990s we added a new slitter section to a Jagenberg winder at a mill in Virginia by gutting it, then upgrading from A-B PLC2 to PLC5 and adding all new Valmet automation.)

Finally, Valmet service and support for your upgraded control system is broader-based and available 24 hours, 7 days a week. Instead of relying on one in-house person or outside consultant, who may or may not be available, when you choose Valmet, your support is provided by multiple trained personnel with many control system installations under their belts.

The remainder of this paper is a review of multiple controls upgrade projects in case study form. They range from very simple single shutdown upgrades, to an extremely complex multi-year installation.

Figure 6. Two of many PLC cabinets on the Valmet workshop floor are ready to ship and be pre-installed at millsite. This can save considerable time on a short shutdown.

Case Study – Mill standardizes on modern PLC system and helps operations group achieve goals

At a southern newsprint mill, an obsolete Siemens S5-150 PLC system was upgraded to redundant Allen-Bradley ControlLogix PLCs. The mill had suffered from hard to get, third party refurbished parts that were of questionable quality. There was no room for expansion in the racks, so adding another valve or control loops for new equipment was impossible. If the PLC went down, the entire line would go down, resulting in a very expensive failure.

The mill decided to do the PLC upgrade during the same week-long shutdown as a planned press loading logic conversion. It was a massive undertaking, requiring significant close planning and prework between Valmet and mill personnel. According to the mill electrical engineer it was "a tight schedule – a very tight schedule." The mill bought the hardware directly from Allen-Bradley and shipped them to Valmet. After converting and testing the software, Valmet shipped the PLCs back to the mill so that network communications could be prepared.

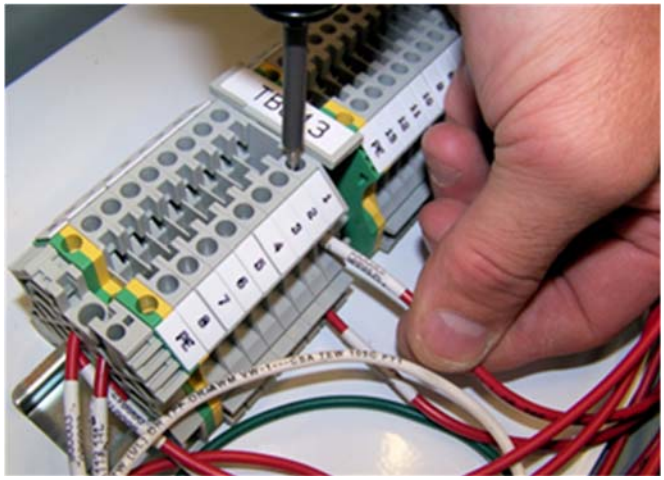

Figure 7. One of the most time-consuming phases of a PLC upgrade is the careful and comprehensive disconnecting, relabeling and re-terminating of field wiring.

The rewiring was a complex undertaking, but the mill was prepared for the week-long shutdown, thanks to aggressive prework. All I/O cables were disconnected, relabeled and reconnected to the new PLCs. In addition all old components were removed. In order to avoid mistakes, teams of two mill personnel, equipped with a digital camera and a diagram, were assigned to document the disconnect/reconnect process. When one team would finish a PLC rack, a different team would inspect their work for any errors. The mill finished this phase in 24 hours, as planned, so that Valmet could then test the entire field I/O.

Startup after the project produced no major problems. According to the mill engineer, the machine "started at the right time" and they "were very pleased." He was particularly happy with the "very good group of engineers from Valmet," who were working with them. The mill is now able to get technical support and replacement spare parts easily.

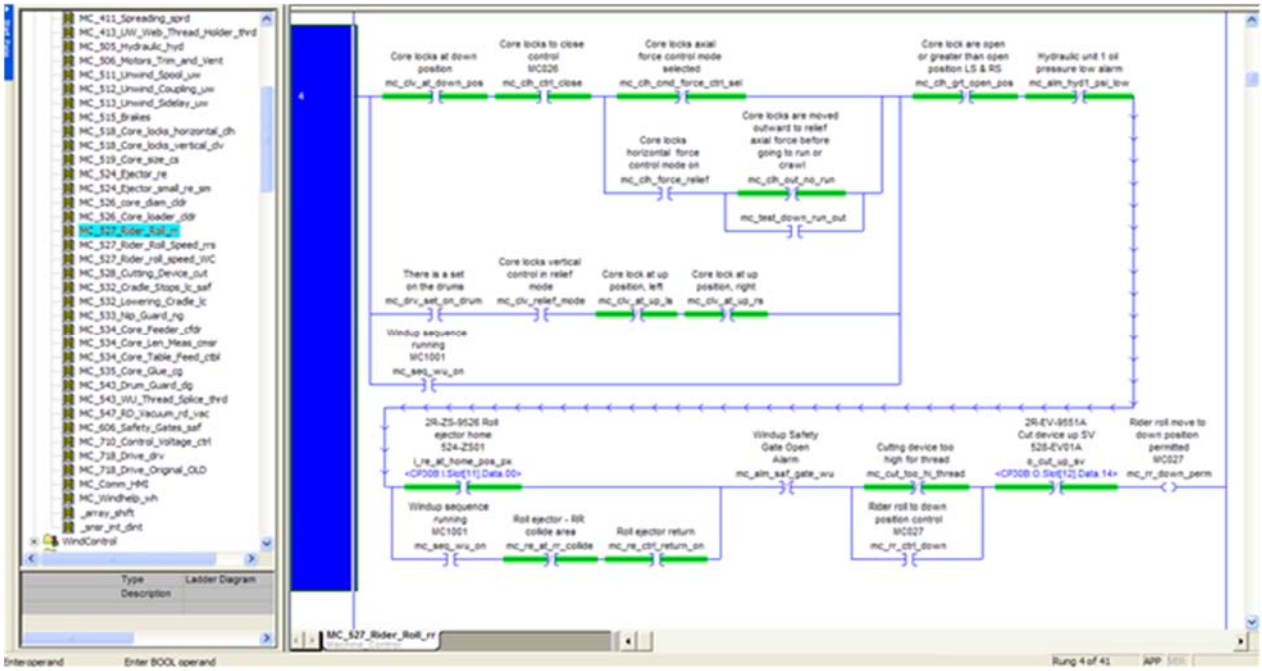

Figure 8. This easy-to-understand ladder logic diagram is for the rider roll movement on a winder (example shown uses the Allen-Bradley RSLogix 5000 development environment).

Their I/O is not maxed out, which allows them much better support for production line growth and "helps the operations group achieve higher goals in terms of production, quality, and efficiency." They also find the A-B Ladder Logic programming language easier to troubleshoot than the Siemens code. The mill has now completed their standardization on one PLC manufacturer, further leveraging their corporate contract with Allen-Bradley.

Case Study – Hydraulic controls upgrade improves performance and reliability, eliminates obsolescence

Sometimes PLC obsolescence is not the only driver for a controls upgrade, as seen in the following case study of obsolete controls…

The hydraulic press loading valves in the manifold located in a basement for a northern USA paper machine were due for replacement. But when mill stores went to purchase new valves, they found that the model they needed was now obsolete and no longer available. Now what?

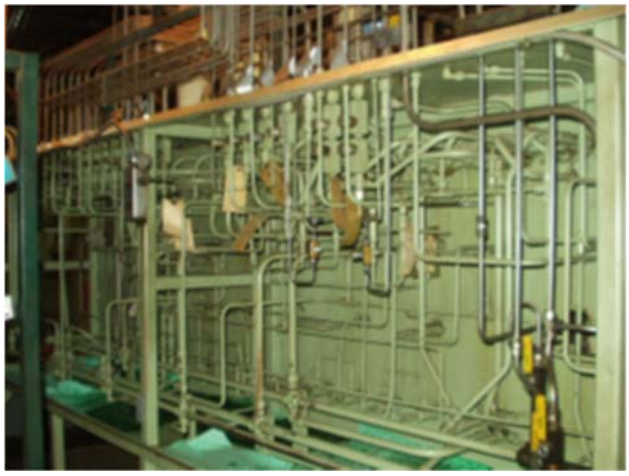

Figure 9. The original valve panel included obsolete, hard-to-find parts and lacked modern safety controls.

Valmet visits the mill

The mill called in Valmet to help determine a good path forward. It was noted in discussions that not only were the valves of 1970's vintage, but the entire press loading control system for the paper machine was of the same vintage. That realization helped to raise the next logical question, were there other press loading components that should be considered for upgrade?

The investigation probes deeper

A Valmet Technical Services Engineer came to the mill to examine the press and help to determine the scope of the upgrade necessary for the machine's press loading hydraulics. The mill maintenance manager expressed concern that by simply replacing the hydraulic valves, the mill would only, "be doing half the job."

Machine operators were having a number of problems that could be directly linked to the 1970's era press hydraulic control system. Not only were the valves obsolete but the existing original hydraulic control system was quite obsolete as well.

Due to limitations of the existing control system, proper and reliable nip impressions could not be obtained. In addition, during machine start-up, when the operators had the former running and then applied loading to the presses, the former stretcher pressure would decrease causing instability in the system and sheet breaks. The operators were forced to make continuous adjustments to the press loadings because the set point would not remain steady. And the 1970's era control system had no troubleshooting capabilities.

Figure 10. The operator local control station for the hydraulics controls upgrade is shown being fully tested on the Valmet workshop floor before shipment to the mill.

Figure 11. The new upgraded valve panel included close isolation valves and additional safety features.

The solution – a hydraulic control upgrade

After further analysis and discussion with the mill, Valmet upgraded the hydraulic control system. After completing the upgrade, a new custom valve rack is in place that makes maintenance and troubleshooting much easier. All obsolete components are upgraded to current with the latest control technology and safety features. The mill has a new Human Machine Interface control featuring first-out logic and user friendly control screens offering operators enhanced and simplified control of the system. (More screen examples are shown at the end of this article.) A duplex filter system was also installed for the manifold supply oil to ensure a good clean supply of oil and enable on-the-fly filter changes.

Excellent results

The mill changed out a sticky proportional valve after the upgrade and the procedure, which used to take up to 4 hours or more, took less than 40 minutes. Nip impressions of the various press nips are now readily done and reliable. Breaks due to stretcher unloading have been eliminated and the entire system is now easy to troubleshoot, thus reducing down time. Press loading is now steady running with closed loop control and the mill set a production record after the upgrade was installed.

Overall, mill personnel are very happy with the results of the upgrade to their press section. According to the maintenance manager, the equipment now is easier to access, operate and maintain.

Figure 12. The hydraulics upgrade included all new PLC control hardware and software which were tested in advance at a Valmet workshop.

Case Study – Texas mill upgrades Allen-Bradley winder controls to latest technology

This case of a bare-bones very small PLC upgrade started when a two-drum winder at a Texas board mill had problems with PLC obsolescence on their A-B PLC5 control system. (Specifically in the slitter positioning controls area.) Parts were starting to fail on the winder control system and replacements where becoming harder and harder to obtain. The mill wanted to address the obsolescence issue as cost efficiently as possible and initially worked with a contractor to do a small-scale fix on their slitter section. Unfortunately, their "home remedy" didn't work out.

Minimal scope for cost effectiveness

The mill asked Valmet and a PLC manufacturer to competitively quote for the project. Initially, Valmet quoted an entire replacement of A-B ControlLogix equipment. However, after discussion with the mill and in order to be cost effective, this was reduced to be just a new A-B processor accompanied with a new ControlLogix Motion Control card. This proposal was also combined with the option for the mill to purchase the hardware directly from A-B, to make the project as cost effective as possible. In the end, the mill decided to get the hardware from Valmet.

In March/April of 2009 Valmet performed the PLC upgrade, converting only the slitter positioning system (Valmet Slitter Positioning System). The new ControlLogix processor worked with the existing PLC5 hardware, and the obsolete motion controller was upgraded to a current model MO2AE card. The Human Machine Interface (HMI) and operator control procedures did not change, making the upgrade transparent to operations.

The results of this PLC upgrade were excellent. The mill also went the same route with their other winder line, selectively upgrading the drives and slitter positioning hardware with Valmet's assistance, to overcome obsolescence.

Case Study – Sticking with Siemens for a short shutdown

A recycled paper mill in Minnesota was suffering from obsolescence of their Siemens S5 PLC system. The controls for their two drum (WinDrum) winder, which supported their linerboard operation, were minimal, i.e. no automation, just machine logic. Parts were becoming difficult to get, and reliability was becoming a risk to be addressed. Having no major investment in another PLC brand, the mill chose to stay with the Siemens platform, but upgrade from the S5 to the modern S7 system.

This upgrade, though relatively small in scope, was particularly challenging due to the extremely short shutdown time. A lot of prework was needed, including lots of planning in the application stage, in order to allow a quick and smooth installation and startup. For example, special wiring connectors were used to minimize wiring time.

The resulting installation was a resounding success, with a paper-to-paper time of ~22 hours.

Figure 13. A modern HMI will greatly reduce the complexity of a machine control benchboard, making it easier to operate (and maintain).

Case Study – Complex multi-phase PLC upgrade of entire line

A mill in Minnesota upgraded their winder PLC six years ago. Initially, they attempted the upgrade with the help of a third party automation consultant. The mill got partway through the planning and code conversion process, but a few weeks before the shutdown mill engineering realized the conversion was nowhere near complete; and there was no way it would be complete by annual shutdown time. The mill asked Valmet to lend a hand. This amounted to keeping the mill's recently purchased hardware, but starting completely over with the software work. The project was not particularly complex, but there were many special steps in the code conversion process that required

knowledge of how that specific winder's controls and automation worked. We were able to help the mill through a successful PLC upgrade on their winder during their shutdown.

A successful project breeds trust

Fast forward a few of years … Now the same mill wants to upgrade their entire PM1 line to A-B ControlLogix. Due to their previous experience, they realized how important a phased approach with comprehensive planning was to an effective startup. Due to their history with Valmet, and the complexity of the total project - the mill decided to engage Valmet to carry out their PLC upgrade.

Breaking down a complex project into easier phases

This first phase took place during their 2007 annual shutdown and converted their PM1 Size Press from Siemens S5 to A-B ControlLogix with PanelView HMI. In addition they chose a niploud upgrade to Temposonics linear displacement transducers (LVDTs) and new pressure transmitters to upgrade their existing raise/lower cylinders which had no feedback.

Phase 2 in 2008 continued with the conversion of the PM1 Calender and Reel, S5 to A-B including some HMI upgrades.

Phase 3 in 2009 involved the Papermaking Line logic (PML), and again converted S5 to A-B. This accounted for all remaining logic on PM1 except for press loading, including diagnostics. For example, this included wet end positioning of the headbox, felt stretchers, rope runs, etc.

Phase 4 occurred in 2010 and comprised the Press Loading Logic (PLL). It was completed in May.

The conversion process in each phase was limited to the PLC and HMI hardware and software, except for the pressure and position transmitters in Phase 1.

Scope: Paper Machine Logic (PML)
Product: Controls Rebuild, Phase III, prework in Metso workshop

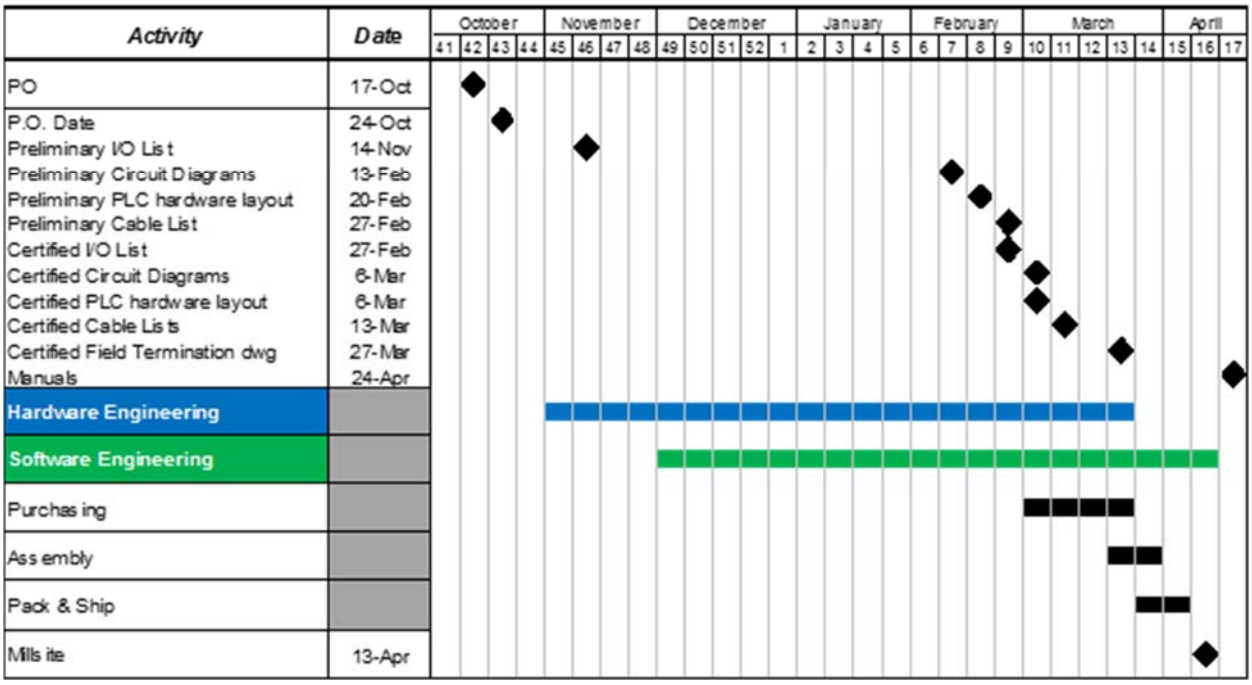

Figure 14. Simplified Gantt chart for the Phase III prework that was performed in the Valmet offices.

What were the notable aspects of this project?

Perhaps the most important aspect of this multi-phase delivery was the continuity of personnel, from both sides of the effort. The same personnel from Valmet, augmented as needed for each phase according to the process expertise required, were active in the continuing project.

The third phase was definitely the largest, due to the massive number of sub-processes to be controlled. Knowledgeable mill personnel assisted as they knew the most about all the nooks and crannies and control cabinets. A couple of the phases were round-the-clock over 7-10 days. Valmet staffed up to whatever level the mill and Valmet felt was needed.

The importance of a phased approach

Spreading out the machine line PLC upgrade over four years was an early critical decision made by the mill. It kept operations, production and maintenance management in their comfort zone. With the obligatory significant planning, the mill felt Valmet knew exactly what needed to be done and was on track at all times.

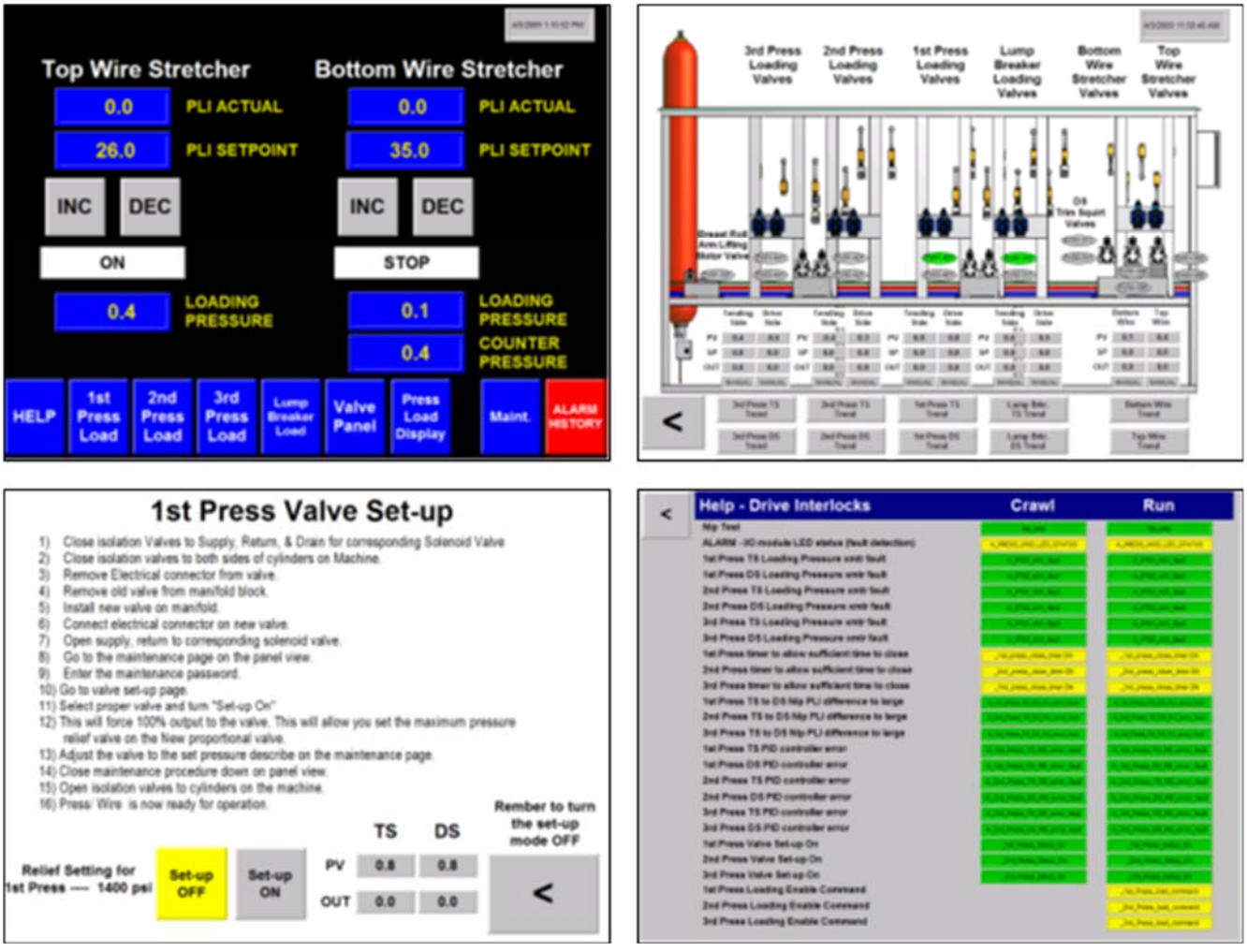

Figure 15. An updated HMI will typically include screens such as those shown here. Top Left: Wire Stretcher controls. Top Right: Press hydraulics status and control. Bottom Left: Step-by-step instructions for valve configuration/maintenance. Bottom Right: Detailed help for each machine function (example shows drive run/crawl commands).

Using a multi-phased approach also meant the budget requirements for each phase were acceptable. The project proceeded in an orderly fashion, with investments approved using a five-year plan, which was easier for corporate buy-in.

With PLC upgrades, by definition, it's hard to see what's happening. The only apparent changes are at the benchboard or in the MCC. But now this mill's controls are good for 20-25 years into the future.

Successful cooperation requires regular communication

The mill and Valmet worked very well together over four years to get the job done, with regular meetings every other week via conference calls with all involved. These regular conferences helped keep both Valmet and mill personnel on the same page, reducing the number of foreseeable startup problems due to missed controls, etc. Valmet hit all the mill's milestones that had been set during the planning stage. We followed all safety rules, and started up on schedule. Nothing dramatic, just getting the job done.

Your mill may need a control upgrade, but the idea of doing an entire line in one fell swoop is daunting. Using a phased approach lowers your risk and allows managed expenditures year-to-year. For this mill the multi-phase approach was best. However, Valmet has the resources to perform a complete machine line controls upgrade in a single phase to occur in one shutdown if desired.

Summary

If you are currently running antiquated PLC hardware – you are assuming more risk than you can afford. Whether it's a small non-automated machine, or an entire highly automated machine line, Valmet is your best choice for bringing your system up to today's control standards.

Valmet's decades of experience with the papermaking process and paper machine controls design, and our advanced control algorithms, combine to produce the most simple, powerful and reliable systems available anywhere. Our control methods have improved with the availability of new PLC and sensor technology, and through the installation of many paper machines.

Valmet provides 24 hours a day, 7 days a week technical and spare parts support for our installed base of hundreds of machines worldwide. Our inventory of several thousand individual part types allows us to ship the majority of our customer parts requests within 24 hours. Our staff of support professionals can help you make the most of your uptime, minimize your downtime and increase your profits.

Figure 16. A modern control system needs 24/7 support from a trusted supplier. And with Valmet, it's only a phone call away – 365 days a year.

This white paper combines technical information obtained from Valmet personnel and published Valmet articles and papers.

Valmet provides competitive technologies and services to the pulp, energy and paper industries. Valmet's pulp, paper and power professionals specialize in processes, machinery, equipment, services, paper machine clothing and filter fabrics. Our offering and experience cover the entire process life cycle including new production lines, rebuilds and services.

We are committed to moving our customers' performance forward.