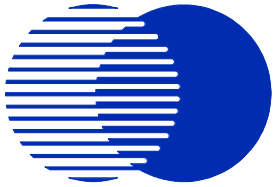


Control Systems International®

≈WHITE PAPER≈

Cost Comparison of Field-Level Automation Systems for Pipeline Operators

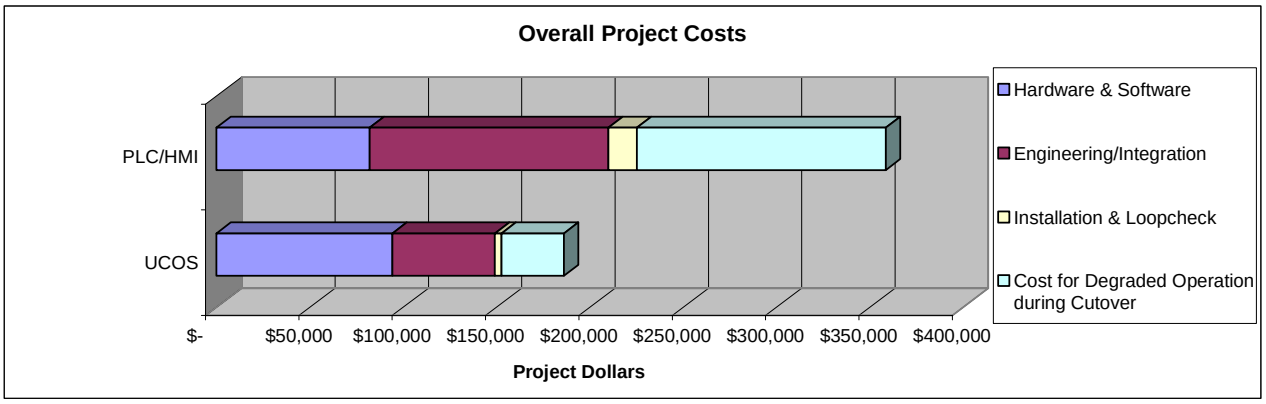
PLC/HMI Technology vs. UCOS

Contents

1 Executive Summary

This paper compares and contrasts the cost of developing a pipeline control system using PLC/HMI technology with the cost of developing a pipeline control system using UCOS. An example pipeline in need of automation is used as the basis for identifying costs. The example pipeline's existing equipment and the company's upgrade goals are identified. In addition, this paper describes the general steps required to automate that pipeline using both PLC/HMI and UCOS technologies. Finally, commercial life cycle costs for each step are presented and evaluated.

The following chart illustrates the overall costs for the project described in this paper.



As the figure shows, the UCOS application requires less time to engineer, install, and startup. When all financial elements of the control system application are considered, UCOS is significantly less expensive than a traditional PLC/HMI solution. This paper breaks down each of the cost categories into more detail, including:

- Hardware and Software
- Engineering and Integration
- Installation and Loopcheck
- Degraded Operation Due to Cut Over

In addition, several intangibles are addressed including:

- The cost impact of standardization
- The costs associated with maintaining unconventional hardware
- Adding a station to an existing system
- Technician resistance to the absence of ladder logic
- Reliability concerns

The time and cost savings identified in this paper are based on feedback from actual PLC/HMI and UCOS users. In addition to the pipeline control system outlined in this paper, here is a brief summary of two pipeline operators.

One operator currently spends $245,000 per station (~200 I/O points) to replace outdated GE Series Six PLCs with new GE 90/30 PLCs and Wonderware's InTouch software. In another part of the country, that same company spends an average of $120,000 per similarly sized station to replace outdated controls with UCOS. Another CSI customer recently completed the automation of four stations. Using UCOS, each station required one man-month to complete. Those same stations had been automated four years previously using PLC/HMI technology that required 6 man-months per station to complete.

2 Introduction

Most of today's crude, refined product, chemical, and gas pipelines are controlled from a central location with Supervisory Control and Data Acquisition (SCADA) systems. Typically pipeline SCADA systems include two major components: a single host system and many field systems.

By host system, we mean the hardware and software installed and operating in the central control facility. SCADA host systems for pipeline applications typically communicate with a number of field systems installed at significant locations along the pipeline (pumping station, breakout storage, receiving station, delivery point, etc.). Field systems communicate regularly with the host system via a specific communication scheme as required by the SCADA host software.

Field automation systems perform detailed pipeline control, such as valve interlocking, ESD protection, and other low-level functions for a specific element of the pipeline (i.e. pumping station). In addition to low-level control, field systems often include a graphical user interface for operations and maintenance personnel at the field site.

For many years, the default technology applied within field systems has included Programmable Logic Controllers (PLCs) and PC-based Human Machine Interface (HMI) software. Field systems are commonly built by engineers working for independent system integration firms or by engineers within the owner pipeline company.

This paper introduces and compares an alternative to the traditional PLC/HMI technology deployed for field automation along a pipeline. The alternative presented is Control Systems International's UCOS system.

This paper summarizes the situation facing an example pipeline company: How to replace and improve field automation at three stations along an existing pipeline. Two options are analyzed:

- Replace existing automation equipment with PLC/HMI technology according to company standards or
- Replace existing automation equipment with a UCOS system

This paper describes the example pipeline in need of automation. Further, it describes the general steps required to automate that pipeline using both PLC/HMI and UCOS technologies. Finally, commercial life cycle costs for each are presented and evaluated.

2.1 Technology Definitions

This section defines the pipeline under consideration, a PLC/HMI solution, and a UCOS solution.

2.1.1 Definition of Example Pipeline

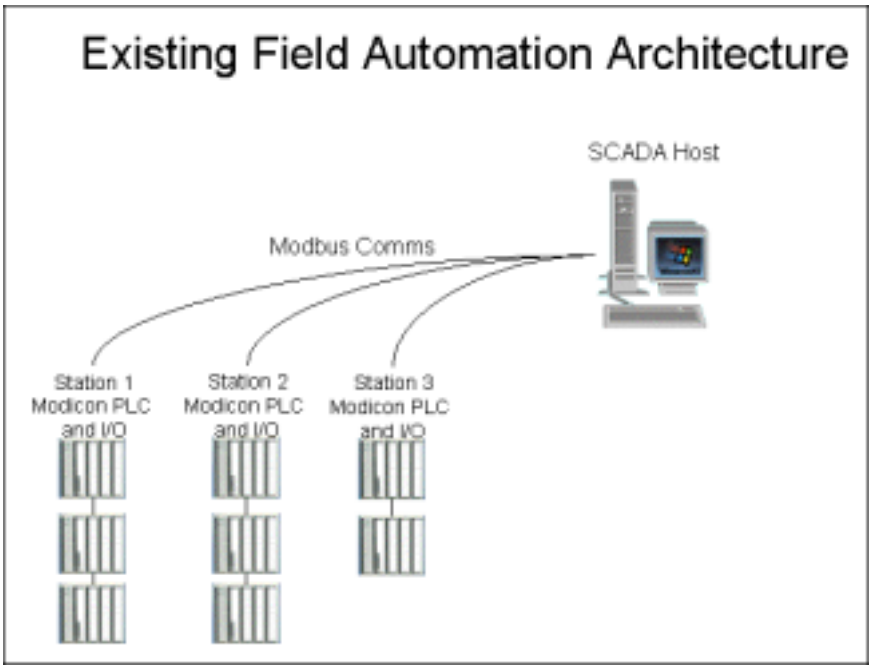
The pipeline to be improved is a single line that carries refined product approximately 150 miles. The pipeline has three stations that are considered for this example: two main pumping stations and one delivery station. The line is controlled at a central location using SCADA host software that communicates via Modbus communication links with each of the three pumping stations being considered. Each pumping station has existing Modicon PLC equipment purchased in the 1980s. This equipment is working, but the original manufacturer no longer provides model-for-model replacement for the PLCs and support will be discontinued in the near future.

No local HMI exists, but the pipeline owner has identified a need for one at each station. Specifically, the owner would like to allow certain users to access screens, control elements, and data from any of the three stations at any of the other stations in a secure manner. Additionally, the pipeline owner would like to have the ability to notify key personnel of pipeline alarms via pager or mobile phone.

In our example each of three stations needs a controller and HMI. The I/O counts are as follows:

	I/O Counts		
	Site 1	**Site 2**	**Site 3**
24 VDC In	120	128	30
24 VDC Out	48	48	32
4-20mA In	74	72	28
4-20mA Out	2	2	2
Total I/O	**244**	**250**	**92**

The following architecture shows how the existing system is configured.



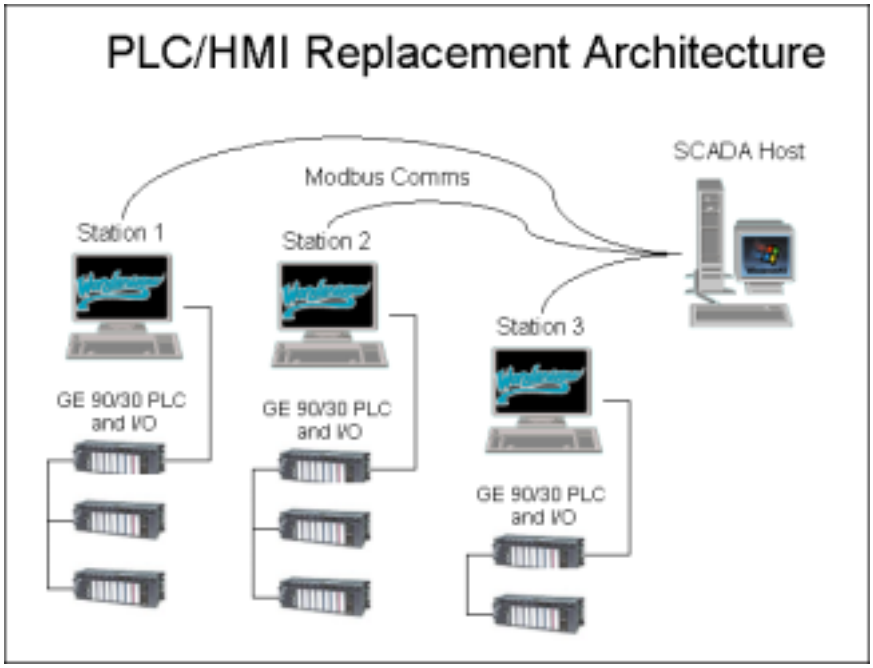
The broad purposes of this pipeline automation project are to migrate field stations to a supportable state, to provide local HMI for field operations/maintenance personnel, and to allow operation and maintenance of any of the three stations from any other station.

To achieve these broad goals, the pipeline owner has determined that this project must replace existing PLCs at each station. Also, one PC-based HMI workstation will be added at each station. All of the labor associated with this work will be done either by an outside systems integrator or by an in-house engineering group. The pipeline owner company has already established network connectivity between stations which will be used for this project.

This paper will compare detailed costs for each primary area of this project: Hardware & Software; Engineering & Integration; Installation, Loopcheck, and Cutover. The following sections will describe the two alternative solutions to be analyzed in this paper.

2.1.2 PLC/HMI

The pipeline owner's corporate standards dictate that General Electric 90/30 PLCs and Wondwerware InTouch HMI software should be used for field automation projects. This solution will address the owner's needs by providing new PLCs and new HMI PCs at each station. Since the existing I/O modules cannot be used with GE 90/30 PLCs, all of the existing I/O modules must be replaced when the new PLCs are installed. Marshalling cabinets exist at each site. Therefore, new I/O modules will be mounted in cabinets and pre-wired in a panel shop to allow for re-termination at the existing marshalling cabinets. This will reduce the amount of time required to actually install the new PLC and I/O. Wonderware stations and PLCs will be connected together via the network interface already available at each station. Communications to the SCADA host will continue to use the Modbus protocol.



Since most readers are familiar with PLC/HMI technology, this paper will not further define it.

2.1.3 UCOS

This section includes two sub-sections: a brief explanation of UCOS technology, and a description of how UCOS will be deployed for this sample application.

2.1.3.1 General Description

In a control system based on UCOS technology, control logic is programmed using a software development tool that is closely integrated with the controller software. The logic is then downloaded to a PC-based controller that executes the logic, directly scans I/O points, and communicates with an HMI running on a separate PC. The HMI is closely integrated with the controller. A given UCOS controller can communicate with I/O made by any of dozens of manufacturers.

The UCOS development tool is called the Engineering Workstation (EWS) and is run on a PC under Windows 2000. The logic programming and HMI development are fully integrated in a single software package within the EWS, which also allows configuration of tags, security, and so forth. System development is based on object-oriented techniques that have long-term, positive impact on system maintenance and upgrades. These object-oriented techniques are patented.

The UCOS supervisory module is called the Operator Workstation (OWS) and is run on an Intel-based PC under Windows 2000. One or more Operator Workstations support full monitoring and control over the process using color graphics, faceplates (Command Windows), and Group Displays. Operator Workstations can be widely distributed with an OWS optionally at each pump station as well as the Master Control Room. Control of the entire pipeline can be handled from any OWS with the appropriate security.

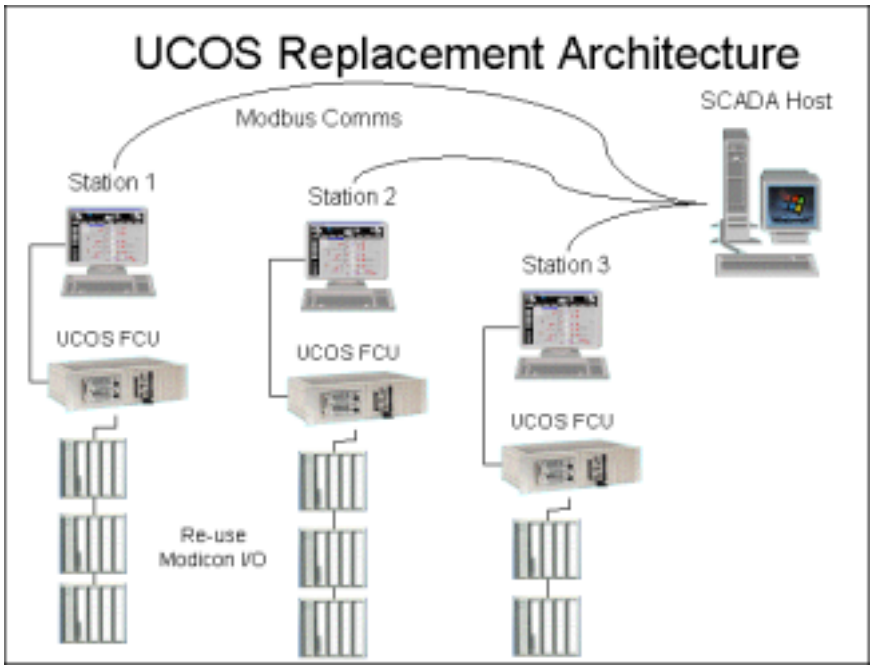
The UCOS controller is called the Field Control Unit (FCU) and is run on a ruggedized, Intel-based PC under QNX, an operating system specifically designed for real-time control applications and accepted in the process control industry. Control logic developed on the EWS is downloaded to one or more FCUs each of which directly scans I/O from multiple manufacturers. FCUs send scanned data to Operator Workstations, send operator commands to I/O, and solve the logic developed on the EWS.

UCOS systems can be designed in a non-redundant or redundant configuration at all levels – from the OWS to the FCU down to individual points.

2.1.3.2 UCOS Implementation

For this pipeline field automation system, one UCOS FCU will be installed at each pipeline station. However, no new I/O will be required. The FCU will communicate with the existing installed I/O modules. This is possible because the FCU can communicate with several different types of I/O sub-systems at once. It is important to note that UCOS is not scanning I/O through a "gateway" or "black box" device, but is actually reading inputs and writing outputs directly – just as the PLC would. In fact, for this application, the UCOS FCU will be installed in such a way that it can control both existing and new I/O. This means the existing I/O can be replaced on an as-needed or scheduled basis. The pipeline owner can gradually move from the existing I/O modules to another I/O sub-system on a point-by-point or card-by-card basis, thereby radically reducing the time that the pipeline must be shut down for cut-over.

In addition to the FCUs, each station will have an Operator or Engineering Workstation. These workstations will provide the local HMI and will communicate with each other and the FCUs over the network interface already available at each station. Communications with the SCADA host system will continue to use Modbus protocol.



2.2 Evaluation Segmentation

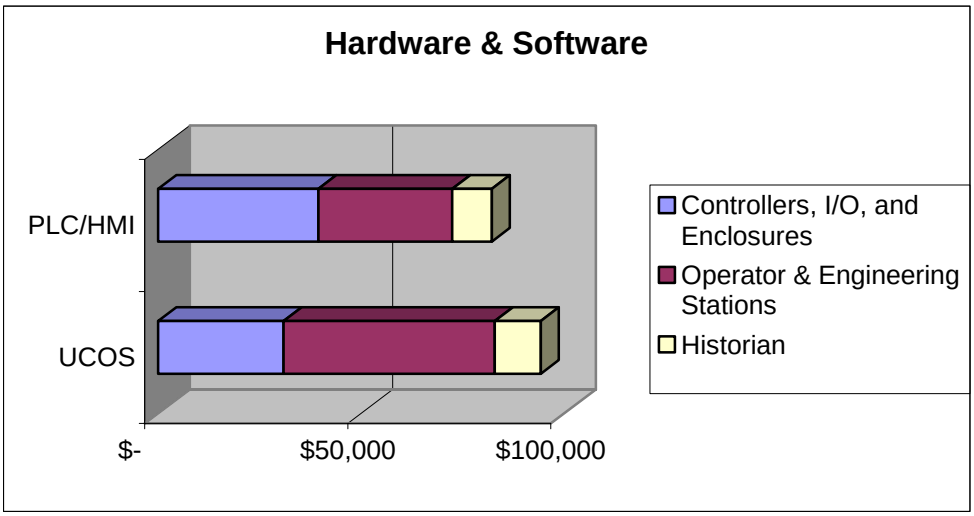
The evaluation is segmented as follows:

- Hardware and Software Costs
- Engineering and Integration Man Hours
- Installation, Loopcheck, and Cutover Man Hours

Each section summarizes the key deliverable items and costs associated with each evaluation option. The paper concludes with a summary of the cost considerations and adds further intangible items that must also be considered as pipeline companies evaluate PLC/HMI solutions against UCOS.

3 Hardware and Software Costs

The following chart summarizes the hardware costs for the two proposed replacement systems. These items are annotated in the remainder of this section.



Hardware & Software Cost Summary

3.1 Controllers, I/O, and Enclosures

Note in the above figure that the controllers, I/O, and enclosures for the PLC/HMI solution cost more than for the UCOS solution.

Because PLCs work with only one brand of I/O, replacing the PLC with a different brand also requires replacement of all the I/O. Since UCOS supports dozens of I/O makes and models, the replacement UCOS system's controller can incorporate the pipeline's existing I/O modules, thus eliminating the upfront cost of both the I/O equipment and the service time to re-wire. However, we noted that the manufacturer no longer provides replacement parts. So, when a piece of equipment fails, it can be replaced with another make and model and can be incorporated into the UCOS controller. All UCOS logic is hardware independent. That means the I/O can be replaced without having to generate new logic, thus saving additional engineering costs throughout the life of the system.

As such, the PLC/HMI replacement requires the pipeline owner to absorb the cost to replace all I/O as part of the replacement project. On the other hand, the UCOS system allows that cost to be spread out over time; the cost will be incurred if and when the existing I/O fails.

Another difference between the PLC/HMI and UCOS solutions is the cost of controller software. Since PLCs are closed systems, they come equipped with an operating system and application software. The controller in a UCOS system is an off-the-shelf, industrial PC to which an operating system and application software must be added. UCOS requires a license for the patented, real-time control executive that is used to drive I/O and perform control functions.

Both solutions require a tool for the engineer/technician to use for development of control logic. Typically, such software for a PLC is a separate license and allows only for logic development. In a UCOS system, the corresponding Engineering Workstation license covers logic, HMI, security, and other configuration tools that are separate expenses in a PLC/HMI solution.

Since the UCOS solution allows for multiple brands of I/O equipment to be incorporated into a single controller, users can select I/O based on practical functional requirements. In this example, the existing Modicon I/O modules may not be able to accept input from a high-speed pulse counter. With UCOS, the user can readily incorporate an Allen-Bradley I/O module that can accept the high-speed pulse signals.

3.2 Operator and Engineering Workstations

The cost of workstation hardware and related operating system software required for this pipeline control system are the same for both UCOS and a PLC/HMI solution. However, UCOS development and run-time licenses are marginally more expensive, although in the long run UCOS often costs less, especially if the system will grow.

HMI licenses are typically based on the number of tags in a system. License prices go up as the number of tags reaches certain license thresholds – 500 tags, 3,000 tags, 10,000 tags, and unlimited tags. The HMI software in our PLC/HMI solution has a limitation of 3,000 tags. These tags are not equal to the number of I/O points in the system. Typically, the number of tags required in the HMI is anywhere from three to seven times the number of actual I/O points in the system. So, the HMI license in our example will quickly reach the limit of its license. No such limitation exists on the UCOS licenses.

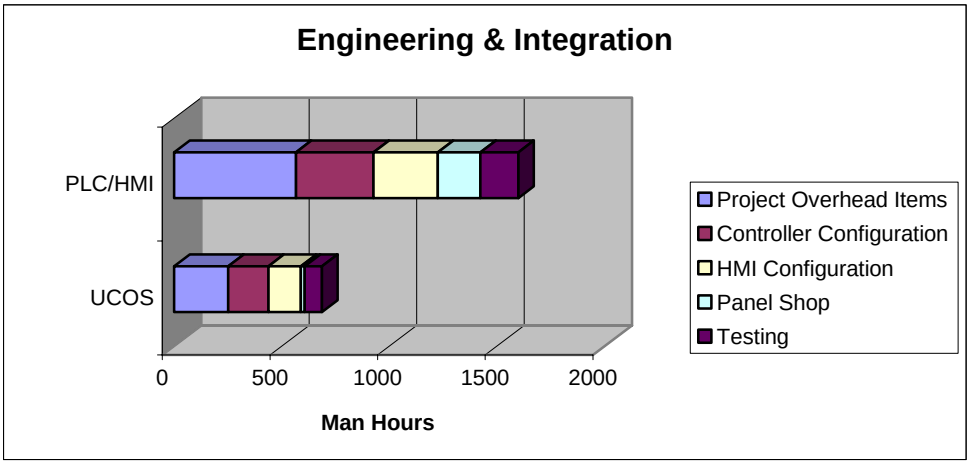
UCOS also includes an alarm notification system required by most pipeline operators that will distribute system alarms to cell phones, pagers, and email. For a PLC/HMI system, this functionality is purchased as an add-on software module.

3.3 Historian

Costs for the Historian are nearly the same for both environments.

4 Engineering and Integration Man Hours

This is a summary of the overall number of man hours required to engineer and integrate a project using the two automation systems considered in this paper. Each of the major components itemized in this chart is explained in further detail below.

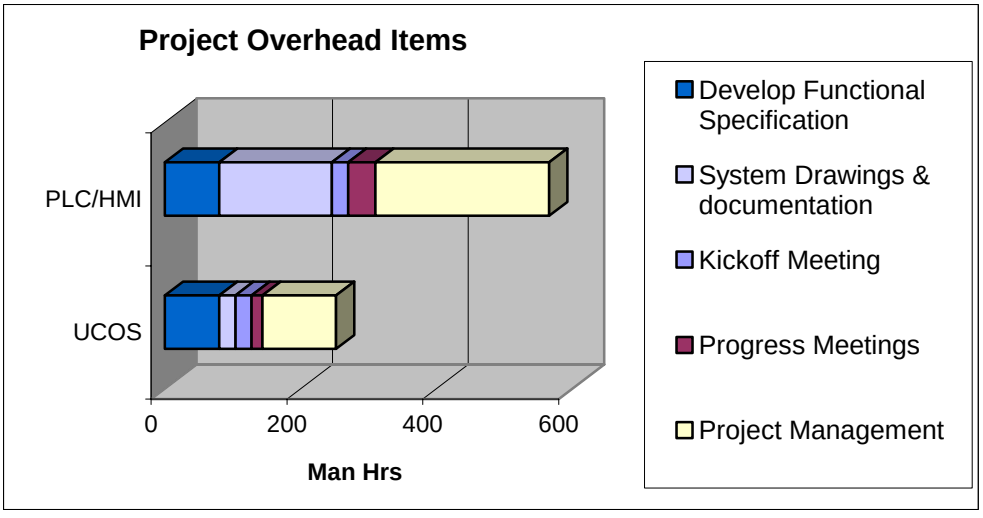


Engineering and Integration Cost Summary

Note that UCOS requires approximately one-third the overall number of man-hours than does the PLC/HMI solution. Factors contributing to the difference in man-hours are explained in the sub-sections that follow.

4.1 Project Overhead Items

This is a summary of the project's overhead items, each of which are described further in this section.



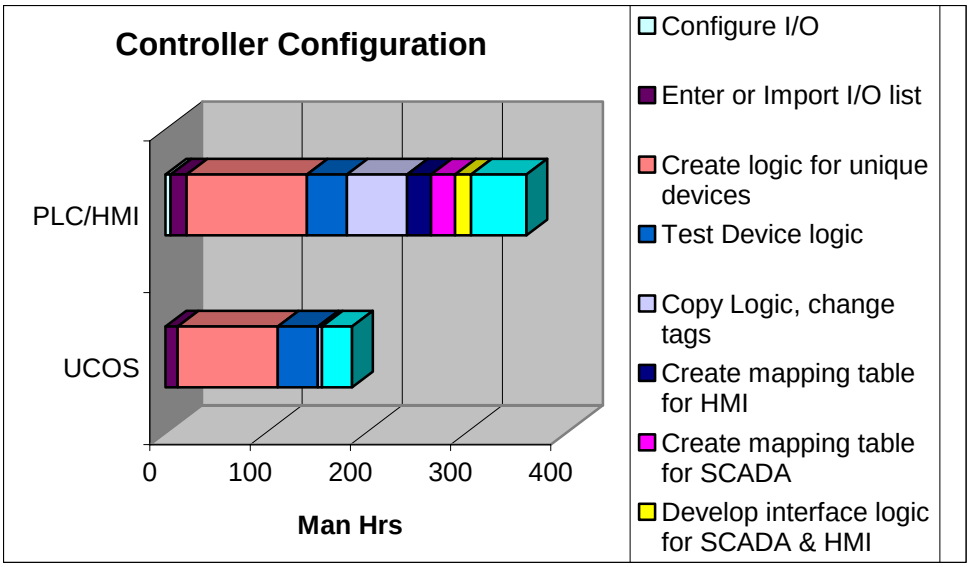
Project Overhead Items

As you can see, there is a sizable disparity between the time used up in project overheads in a PLC/HMI solution versus a UCOS solution. Most of this disparity is attributed to the following:

- PLC/HMI development requires more overall hours and, therefore, more project management, travel, and progress meeting time.
- The PLC/HMI option requires a significant amount of time to prepare installation and field wiring diagrams for the installation of new I/O modules and related equipment. The UCOS option does not require new field I/O and, therefore, does not require preparation time.
- Development of a functional specification for the automation project will require roughly the same amount of time for either type of control system. The functional specification is a single document that describes the control system in detail including: a) how control schemes will work, b) how operator graphic screens will look, c) color conventions, d) naming conventions, etc. The PLC/HMI option will require some additional work here to define memory mapping within the PLC and to describe communication standards for PLC-to-HMI data flow. This task is handled automatically by UCOS and, therefore, does not require extra time.

4.2 Controller Configuration

Below, note that the UCOS solution requires significantly less time for controller configuration than the PLC/HMI solution requires. This is due to the patented, object-oriented, template-based configuration technology built into UCOS that allows engineers to configure and test field device logic and HMI graphics prior to insertion into the project. Subsequent insertion of those devices typically takes a few seconds. This not only results in more consistent logic and HMI graphics, it also requires less time to configure.

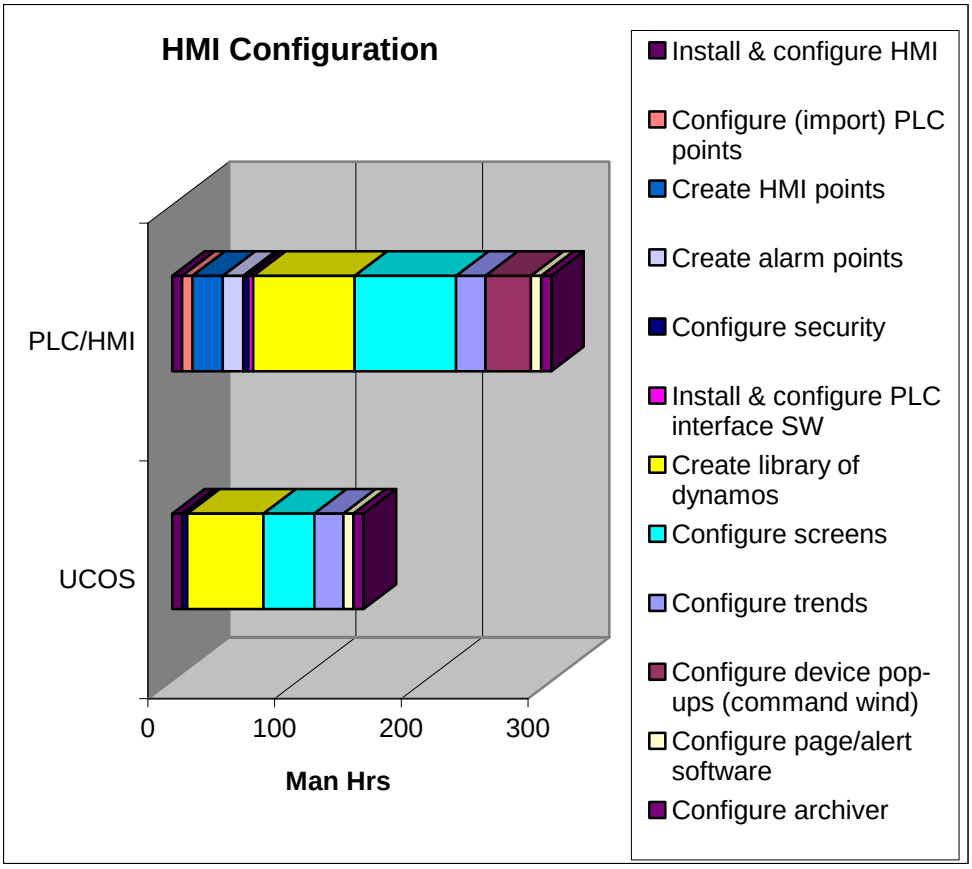


Controller Configuration

4.3 HMI Configuration

As stated in the previous section, UCOS HMI graphics require significantly less time to develop due to the patented, object-oriented, template-based technology in UCOS. Once a device graphic is drawn and associated with a device template, insertion of the device automatically generates an HMI graphic for that device, including complete run-time dynamics (movement, color change, shape change, etc.). Inserting the device into the project also results in an appropriate operator faceplate (Command Windows) requiring no configuration effort at all. (They can, however, be further customized.)

Because most HMI systems are not integrated with the PLC executive, configuring an HMI with a standalone system typically requires significantly more time, including mapping memory addresses.

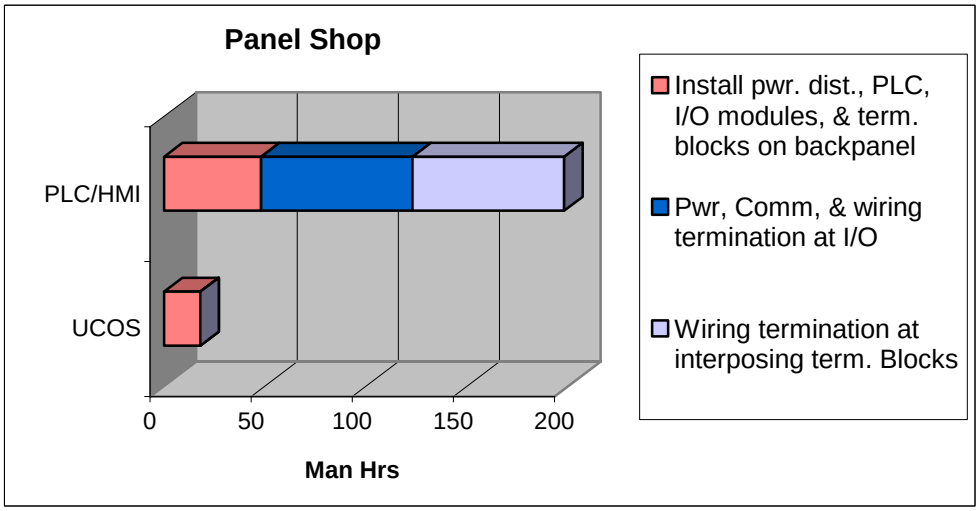


HMI Configuration

4.4 Panel Shop

Panel shop costs include the procurement of field enclosures as well as the mounting and wiring of controller and I/O equipment within and among enclosures.

Since the PLC/HMI solution requires the replacement of all existing I/O modules, it requires significantly more time and cost to implement than does the UCOS solution. The UCOS solution requires mounting the controllers and preparing interconnection wiring. However, since UCOS can incorporate existing field I/O, no additional panel work is required to mount and wire new I/O modules.

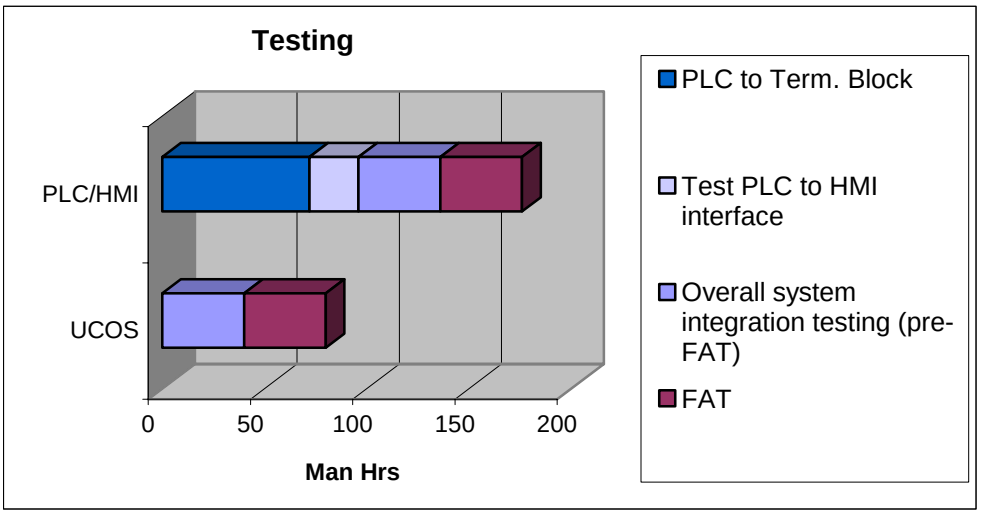


4.5 Testing

The significant difference in testing hours between a UCOS solution and a PLC/HMI solution is due to the fact that the PLC/HMI solution must be tested in several phases:

- PLC logic and memory mapping must be tested for its own integrity
- The PLC-to-HMI interface must be tested
- The system as a whole is tested to confirm that each control loop operates correctly from the operator screen to the I/O module and back again

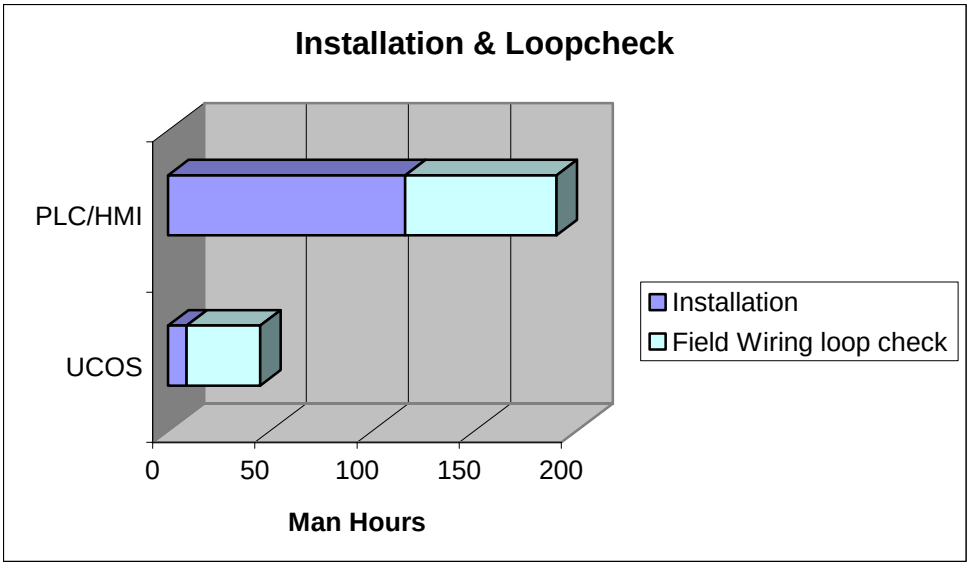
In a UCOS system, everything is tested, too, including control logic, tag definitions, HMI graphics, alarming, and logging. However, these components are tested during the template configuration phase prior to insertion of each device into the system. This allows problems to be worked out before engineers actually insert the hundreds or thousands of devices needed by the project into the system. This not only results in a more consistent, reliable implementation, it also takes less time. Since UCOS operates in an integrated environment, memory map and controller to HMI tests are accomplished in a single step.



Testing

5 Installation, Loopcheck, and Cut-Over Man Hours

The chart below illustrates the relative amounts of time required to perform installation and loopcheck in the two systems for our example project.



Installation and Loopcheck

5.1 Installation

Installation time required for UCOS is very small due to the fact that the UCOS system will re-use the presently installed I/O equipment. Therefore, the only thing that gets installed for the UCOS application is a new cabinet at each site to house the new controller. The controller must also be connected to the existing I/O equipment.

For the PLC/HMI solution, installation will require the removal of existing I/O and wiring from each site. After removing existing equipment and wiring, electricians will install the PLC and I/O. These new I/O modules would be pre-wired to cables that could easily be pulled to site marshalling panels. Electricians would then land and label these new wires in existing site marshalling panels.

5.2 Loopcheck

Loopcheck is the task that must be performed to confirm that field elements are properly connected to logical and graphical elements of the controller and HMI. Loopcheck will be performed similarly for both the PLC/HMI and the UCOS solutions. Engineers and/or technicians will progress point-by-point through the control system confirming that changes in the field are properly detected and indicated in the controller and HMI. The process takes longer in the PLC/HMI solution because of the following:

- Since the PLC/HMI solution requires all wiring to be re-landed at the marshalling panel, it is likely that more wiring problems will be discovered.
- When loopcheck problems are discovered, the PLC/HMI solution requires more troubleshooting. Specifically, engineers must confirm that field wiring is properly connected to the PLC. The PLC logic must then be examined for errors. Finally, the interface between the PLC and the HMI must be investigated.

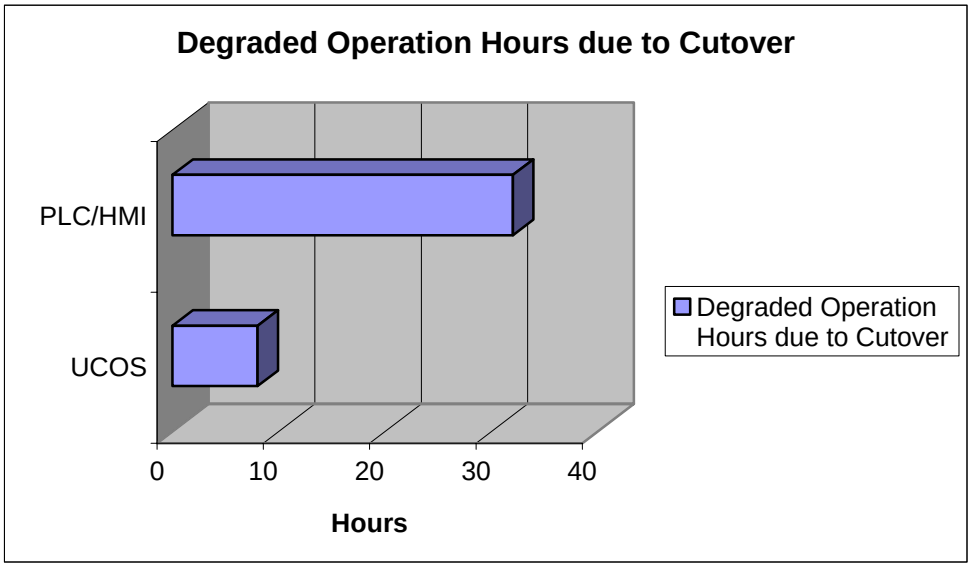
Typically, the PLC/HMI system requires multiple software interfaces to be accessible, including the programming environment, the graphic run-time environment, etc.

These steps are also performed in UCOS. However, in UCOS tag addresses, control logic, and HMI graphics are objects that are pre-tested together prior to insertion into the project. During the UCOS loopcheck phase, the engineer simply needs to confirm a UCOS tag's connection with the I/O. Control logic and HMI testing occur simultaneously with field wiring tests since logic and HMI are integrated within UCOS devices.

5.3 Degraded Pipeline Operation for Cutover

For most pipeline operators, degrading the operation of the pipeline is the most expensive element to be considered when evaluating automation improvements. Most pipeline operators know how much money is lost for each hour of downtime or degraded operation. In some cases, saving one or two hours of pipeline operation can more than make up for the cost of the new control system.

Pipeline operation will be degraded for the duration of time required to install and loopcheck. These project processes require that the portion of the control system being installed or checked must be offline. Most pipeline operators are able to plan the installation and cutover in such a way to allow the pipeline to continue some minimized operation without requiring total pipeline shutdown. In any case, the degradation of pipeline operation is



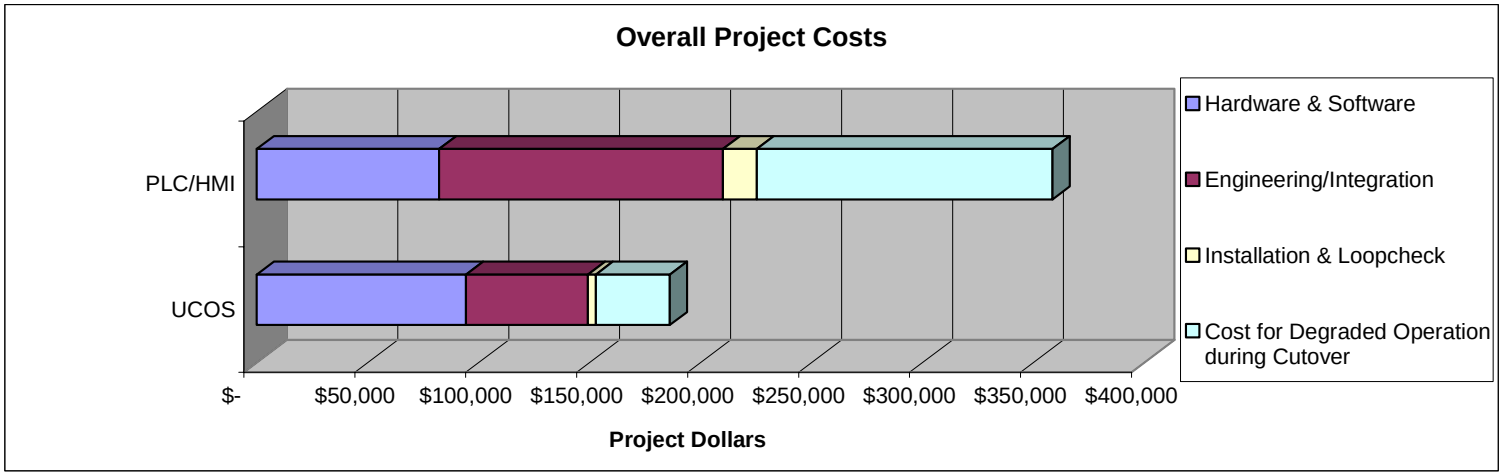
an expensive element that must be considered.

The PLC/HMI solution requires more time to install and check loops than the UCOS solution requires. In addition, all UCOS devices are tested prior to their insertion into the project. That means UCOS logic is implemented consistently throughout the project and requires little or no time during cutover to resolve discrepancies caused by inconsistent implementation.

6 Conclusion

6.1 Cost Summary

The following chart illustrates the overall costs for the project described above (two pumping stations, one delivery station). In order to provide a comparison of total dollar costs for each option, two arbitrary values underlie this chart. Since, previously this paper provided comparisons for labor in Man Hours, this chart assumes an average hourly rate of $80 for labor. Additionally, this chart assumes a cost for pipeline downtime of $100,000 per day. These values are selected based on feedback from pipeline companies and are believed to be conservative.



In summary, the UCOS application is significantly less expensive when all elements of the control system application are considered. UCOS reduces the overall complexity and risk associated with most field automation applications because it can be engineered in less time, deployed in less time, and installed in less time.

6.2 Intangible Elements

As with most economic decisions, the evaluation of field automation technology includes several things that are difficult to assign a quantifiable value. Several of these items are discussed in this section.

6.2.1 Standardization

Many pipeline companies have set corporate standards that dictate which PLC equipment and HMI software should be used to build field systems along their pipelines. Unfortunately, for most pipeline companies, standardization efforts have been limited to merely defining the types of hardware and software that comprise the field automation systems. Frequently, these standards do not include repeatable processes for the development and deployment of field systems. This means that each engineer or technician that touches the control system does so with his own set of tools and preferences. It is not uncommon to learn that while two pumping stations have the same pumping equipment, piping layouts, and automation equipment, the control schemes for operating the two stations are different. Typically, the reason is that a different controls engineer – each with his own "best" way of controlling a station, created the automation system at each station.

Although some pipeline owners have created standards to address the methods for PLC programming, the standards are practically impossible to track and enforce.

UCOS provides an environment where controls engineers find it easier and more productive to use control elements from the library of available templates, thereby enforcing whatever standards have been created within the system. The library of control elements becomes a repository for corporate standards that are perpetuated throughout the system.

6.2.2 Unconventional Hardware

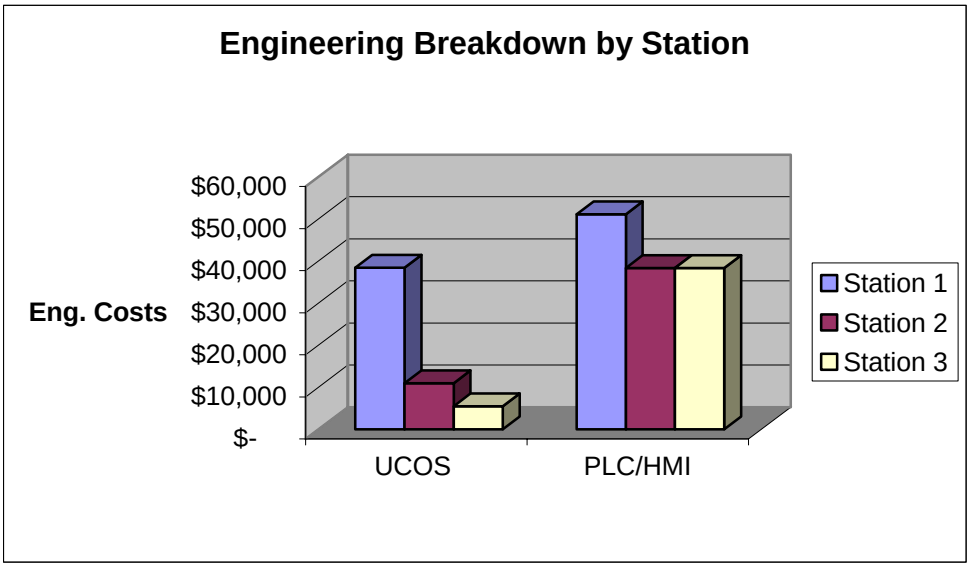
Every pipeline company has a few remote sites with PLC, RTU, or I/O hardware that might be considered strange and peculiar by conventional standards. Most companies have to either set aside sizeable budgets over a number of years to overcome and eradicate "one-off" hardware components or continue to purchase expensive maintenance and support for multiple systems.

Unlike PLC/HMI solutions, UCOS can incorporate I/O modules from a wide variety of manufacturers. This allows pipeline owners to avoid the significant costs associated with removing, replacing, and re-wiring existing systems with unique installed equipment.

6.2.3 Adding a Station

You can see from the analysis presented previously that the overall time and resources required to implement a PLC/HMI solution is greater than that required for a UCOS application. As you add stations to the system, the overall cost gap between a UCOS and a PLC/HMI solution continues to widen, that is, UCOS gets progressively less expensive as the number of field stations increases. This is because UCOS can more rapidly incorporate its elemental control devices into a complete station automation system than can a PLC/HMI solution.

For our example application, the pricing breakdown for engineering at each of the three stations follows the trends below:



Engineering Breakdown by Station

6.2.4 Technician Resistance to the Absence of Ladder Logic

Since UCOS provides a Field Control Unit (FCU) that replaces a PLC, most users are concerned that technicians and controls engineers will resist learning a new method of programming.

Most technical people already familiar with PLC programming find the programming environment of UCOS very useful. Instead of ladder logic, UCOS uses a patented concept called device diagramming. Device diagrams are control schemes built by connecting a number of individual control devices. These devices each contain logic. The logic is defined in a graphical Boolean environment that uses functions very similar to ladder logic – timers, counters, AND gates, OR gates, etc. Most PLC programmers find the change from ladder logic to device diagramming initially unusual, but ultimately familiar and more productive.

In fact, PLC programmers are typically most able to recognize the significant value that UCOS provides. PLC programmers already know how much effort is required to troubleshoot PLC logic that was written by another programmer. With UCOS, troubleshooting is more straightforward and does not require some of the more tedious work associated with finding PLC logic problems (management of data tables, cross-referencing contacts, managing indirect addressing, etc.). UCOS provides utilities that allow technicians to rapidly identify problems down to the device level, and then to identify and solve logic problems within an individual device.

6.2.5 Reliability Concerns

One of the most important reasons pipeline companies have migrated to PLC technology is reliability. Consider this statement: PLCs are proprietary hardware – running a proprietary operating system – that can only execute programs developed using proprietary software – and can only use proprietary I/O modules. If that statement applied to a personal computer, no one would buy it. If you did own such a PC, you could not easily add extra memory, upgrade the motherboard, incorporate a new high-speed DVD burner, or download photos from your digital camera. The only reason you would consider buying such a computer would be if you knew it would never stop running. That is the reason most pipeline companies have embraced PLC systems in the field. In spite of their proprietary nature, PLCs rarely stop running.

Because UCOS systems use ruggedized, Intel-based controllers instead of PLC processors, engineers have concerns about hardware reliability. Many engineers evaluate reliability based on Mean Time Between Failure (MTBF). MTBF rates are calculated on a theoretical basis by combining known failure rates of system components. MTBF values for UCOS FCUs are comparable, if not greater, than those for PLC equipment commonly used in pipeline field automation. Because of the theoretical nature of such analysis, however, MTBF is not always the best gauge of system reliability. Those already using the system best evaluate reliability. Since the introduction of UCOS in 1996, users have reported only two hardware failures in the field. Both failures occurred in systems where redundant FCUs were installed and no field downtime was recorded. FCUs can be made optionally redundant. This is a feature not frequently available for PLC applications.

6.3 Conclusion and Vendor Contact

The time and cost savings identified in this paper are based on feedback from actual UCOS users. In the example presented here, the UCOS system requires approximately 53% less labor than is required for a PLC/HMI solution.

Other UCOS users have reported similar results for projects of varying scope of supply. Currently, one liquids pipeline company is spending $245,000 per station (~200 I/O points) to replace outdated GE Series Six PLCs with new GE 90/30 PLCs and Wonderware's InTouch software. In another part of the country, that same company is spending an average of $120,000 per similarly sized station to replace outdated controls with UCOS.

Another CSI customer recently completed the automation of four stations. Using UCOS, each station required one man-month to complete. Those same stations had been automated four years previously using PLC/HMI technology that required 6 man-months per station to complete.

The example application presented in this paper illustrates the significant time and cost savings that are achieved by using UCOS to replace an outdated PLC Field system while leaving existing I/O in place. Similar savings are achieved for green field projects as well as retrofit projects where all I/O is replaced.

The vendor of UCOS, Control Systems International, can be contacted as follows:

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