Go Big or Stay Simple:
Balancing Needs and Wants with Maintainability in Control Systems

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Abstract

A vast majority of the mechanical and analog systems have been, or are slated to be, replaced with digital solutions. Balancing the needs and wants of these systems with maintainability should be considered during the specification stage of the project. Paramount in the decision making should be safety and operability. Planning how the system will function in the event of an emergency or failure of a single or multiple components will save countless difficulties if done in the specification stage. This can determine if the unit will be out of service for hours or days, or worse cause significant damage to critical structures. A simple equipment system with complex software that could include the excitation, governor, water control and plant control all in one can minimize overall component costs but may result in unanticipated results that may be difficult to anticipate or test during commissioning. A system with more components that separates the functions into simple tasks may be advantageous for maintainability but may result in more equipment costs. Also important in the initial stage is the abilities of the maintenance staff. Will they be able to learn the system quickly and minimize both down time and the necessity of hiring outside expertise? Lastly, planned obsolescence needs to be taken into consideration. Components manufactured ten years ago will not likely be available as replacements. Costs balanced with operability can be determined in the specification and planning stage.

Introduction

Organizations are challenged with replacing older equipment. Newer technology is tempting for many reasons. Critical in the conception phase of such a project is a clear definition of the issues to be solved, properties and functions of existing equipment, clearly defined goals of the new equipment, attention to detail in the specifications and a comprehensive plan for implementation. This paper will cover technics to help define the issues and assist with selecting the solution.

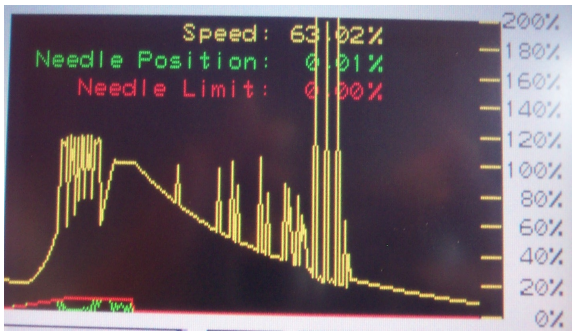
Define the Issues

Defining the issues is the most important aspect of a project. Clearly defined issues assist in a deeper understanding of the items that need to be resolved by replacing or adding equipment. The project can easily go off track and end up costing significantly more without truly fixing the original problem. Projects are often defined by goals as apposed to issues. While this is important, the goals must be clearly aligned with the issues. In many instances goals have taken projects off track. Cool shiny things are no replacement for equipment designed and constructed

to perform specific tasks that make the equipment easier, more cost effective and easy to understand to run and maintain.

The following are suggestions for questions to assist in understanding of the issues:

Where are the points of failure presently?



The points of failure are a good indication of not only what is to be fixed but where it should be fixed. Good documentation on problem solutions for existing equipment should be used as a guideline for new equipment. Considering a complex controller will reduce the number of devices that are prone to failure. Considering a simple controller will allow the staff to use existing knowledge.

How long did it take to fix?

This is one of the key points to selecting separate or combined equipment. Complicated wiring schemes causing difficulty in finding the source of a failure could be reduced by combining functions in a single controller and with properly tested software, could significantly reduce troubleshooting times. However, even with many components moved into the software, any intermittent issues might remain difficult to locate. A plan should be implemented to use the controller to reduce outage times long term. This requires staff knowledge and access to key points of information. Especially during the initial stage after the project in complete, a specialist may be required to assist with troubleshooting for complex controllers. Travel and accessibility of the specialist should be considered.

How much did it cost?

There are many costs associated with failures, lost generation, violation of licensing, employees costs, equipment replacement costs…All of the costs should be taken into consideration. This is also where planned obsolescence is considered. Simple controllers may be easier and more cost effective to replace initially. Complex controller may reduce the costs by reducing the addition and ancillary devices required.

What are the skill levels of the staff with regards to the existing equipment?

Very often there are people on staff that have extensive knowledge of the existing system. These people are the greatest asset, and sometimes hinderance, to implementing new equipment. They should be heavily involved in the process. This is advantageous for two reasons. First, their knowledge will help identify areas for improvement and potential challenges. Second, getting their buy in to the new equipment has both long and short term benefits. It is important to remember that these are the people who will be “living” with the equipment once the project is completed.

What are the safety points?

First and foremost should be safety. Location plays a key roll in safety. One of the greatest points of failure is communication. Long distance operation of a device has risks that should be evaluated. Combining dam operations in the plant controller requires careful evaluation of the desired safe position. In the event of loss of communication, where should the device place the equipment under it's control?

Power at a hydro site come in two form, electrical and mechanical. Mechanical power in the form of water comes in, electrical power comes out. Additional safety points can be built into controllers to avoid activating more aggressive actions but should not be used as a replacement for any critical safety feature. Water control features have often ended up on the "oh yeah" list. The power contained in water should be seriously considered while selecting control schemes.

What are the skill levels of the staff with regards to new equipment?

Again, it is extremely important to involve the people who will be directly working with the equipment once the project is complete. Engaging these people during the installation and commissioning phase has found to have great benefits long term, especially for the more complicated control schemes. Often a phased in approach is advantageous. Direct replacement to existing equipment with task only related to that equipment has been found to be beneficial in training. As the staff becomes more comfortable with the new controls, items can be combined in more comprehensive controls.

What additional improvements could be made that would facilitate improved operability and reduced down time?

This question should be asked last and is often asked first. Once the existing issues and equipment is thoroughly understood, additional improvements can be considered. Special care should be taken to keep the specific role of the equipment foremost while considering additional functions.

Describe Existing Equipment

A thorough understanding of the existing equipment is of utmost importance. It is impossible to gauge the successful operation of new equipment without this understanding. Occasionally, new equipment is selected to fix an issue unrelated to the equipment it is replacing. It can be exceptionally frustrating to spend time and money only to have the same problem reappear.

A full description of all of the affected or potentially affected existing equipment, including location, is critical to the success of this type of project. It is especially important to list the affected equipment. For example, if the problem is that the spill gates are not fast enough to adhere to a new standard, replacing the controller may not be enough to resolve the problem. All of the motors, cables, bearings, side rails and all other aspects of the spillway need to be evaluated.

Most all of the equipment in the powerhouse can affect the operation of apparently unrelated devices. An example is the excitation effect on the governor. Unstable voltage control can affect the unit speed and thereby the governors ability to control speed. Batteries need a thorough evaluation. The digital controls will require significant uninterrupted power to operate properly.

Describe the Role of the New Equipment

Describing the role of the new equipment will assist with equipment selection. In general, the new equipment should perform the same as the existing equipment. All of the issues should be taken into consideration. This is the portion of the project where the decision should be made as to combine or separate functions.

The scope of the new equipment will depend on the staff. Simple equipment can be installed commissioned and maintained by a wide variety of personnel. As the equipment becomes complex, so does the staffing. Software is an excellent tool to assist in troubleshooting a problem. However, the staff must understand how the software works, how to search and follow through.Technicians and engineers may be required to assist in maintaining the equipment when the software, or controls in general, become more complex.

The specification should clearly define the solution desired. Too little information in the specification can result in the project going off track, increased costs, and/or project creep. Too much information could result in unnecessary costs, unnecessary equipment and a loss of potential opportunity for a different more efficient and cost effective solution.

The specification should also clearly state the location for the new equipment. The equipment should be installed as close as possible to the device(s) it will be controlling. This has two main benefits. First, safety will be increased by possibly reducing wiring and/or other communication issues. Second, troubleshooting will be more efficient.

Canned software or custom? The benefits of canned software is the previous testing. Most often, this software has been implanted in other sites and has been through a thorough shakedown. Custom software may be more concise for a location, making it easier to troubleshoot. However, more intense testing is needed to eliminate the “gotchas.”

Implementation

Implementation should also be considered during the specification phase. This can determine if a consolidated controller is the proper choice. Simple controllers can potentially use existing wiring, or requires minimal additional wiring. Complex controllers will require substantial new wiring. The advantage to the simple controller is clear with minimal new wiring. The advantage to complex controllers are the reduction of potentially a maze of older wires. With either choice it is recommended to run more wire than is required for the design to accommodate future changes. The time for installation and commissioning will be longer for a complex controller. but may save time for troubleshooting and maintenance in the long run.

During the actual commissioning, care should be taken to avoid scope creep. Once the staff becomes comfortable with the concept of the new controls, they begin to see the advantages. This often leads to more requests to add to the design. Extra wires and room for more components should be considered to allow for future expansion. The commissioning should focus on the original plan. Engaging the staff during the commissioning phase will lead to a greater understanding and ability to troubleshoot once the project is complete.

Conclusion

Following these defined steps will assist in selecting the proper scope and equipment to effectively and efficiently solve the issues desired. Avoiding scope creep by focusing on the issues to be solved and challenges in solving them will reduce outage time and costs both during the project stage and for the life of the equipment.

Author

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