MAPS – A MULTIDISCIPLINARY TOOL FOR LIFE CYCLE MANAGEMENT

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ABSTRACT

Designed to offer a fully integrated design, engineering and management tool, MAPS (Mitsubishi Adroit Process Suite) can significantly reduce automation system lifecycle engineering effort and costs, offering savings of up to 50%. It delivers tightly integrated SCADA and PLC solutions built around pre-configured and tested engineering libraries, builds in a full suite of diagnostics and maintenance tools, and integrates full document management capabilities that help users to maintain 'as built' quality documentation throughout the lifecycle of the plant.

MAPS adds value throughout all the phases of the automation system project, from process design to engineering, development of the control systems, installation, commissioning, start-up and acceptance testing, all the way through to operations, maintenance, repairs and ongoing upgrades. It supports consistency and integrity right across the automation system, and improves quality while reducing cost.

MAPS is a step change in the way a complex plant is designed, installed and maintained, with a streamlined approach that drives down costs and boosts productivity. The MAPS methodology allows automation systems to be built around pre-configured and tested engineering libraries of PLC function blocks and associated SCADA graphics. This standardized approach to projects reduces engineering time and effort throughout all the phases of development, delivery and operations. The wizard based approach to project development allows cost reductions of between 30% and 50% to be achieved by reducing the time spent on development and configuration. MAPS also provide integrated diagnostics and maintenance tools that significantly boost system availability.

Where different engineers, different project teams or even different companies are involved in the project across its full lifecycle, MAPS helps to ensure that optimum efficiency of the automation system is maintained – from the design phases to the ongoing operations phase which will often see the system evolve beyond its initial specification – by providing an integrated document management solution that maintains 'as built' quality documentation. The system reflects up-to-date configuration information, and ensures that with every change in the design the project databases and documentation are synchronized. MAPS also offers the ability to centrally back-up a project.

MAPS is a further example of how Mitsubishi Electric's e-F@ctory Alliance is providing customers with enhanced solutions built around its own core product technologies combined with the market leading technologies of partner companies.

1. INTRODUCTION

Today's engineering disciplines are far more networked. Not only engineers with extended teaming capabilities are required. The tools they use have to interface with neighbored engineering tools to be able to exchange their results.
The reason behind that increased interconnectivity is the need for an increased efficiency that enables machine and plant manufacturers to increase their profit.

The subject of this paper is to show how a tool like the Mitsubishi Adroit Process Suite (from now on entitled as MAPS) can contribute to an increased efficiency while engineering machine equipment for a plant.

The first part will describe three engineering disciplines that are unified in MAPS. The second part will place these disciplines in the value chain of a plant manufacturer. The third and last part will show how these three disciplines interfaces to deliver a more efficient work flow.

This paper will only focus on the electrical engineering. Construction, finance and logistic will not be the subject of this paper.

2. ENGINEERING DISPLINES IN MAPS

MAPS unifies three engineering disciplines: Electrical drawing, programing of the PAC (Process Automation Controller) and engineering the SCADA (Supervisory Control And Data Acquisition). All three are software packages.

2.1 Electrical drawing

The purpose of the electrical drawing is to document the electrical wiring of the different automation objects. An automation object can be a PAC, an inverter or just an emergency stop.

Electrical drawings are one of the most critical and important parts of the documentation, since they are needed for maintenance purposes. Maintenance and service engineers refer to these electrical drawings while working on the equipment. If these are not up to date, an extensive reverse engineering needs to be done previous to the maintenance and service work. That implies longer scheduled maintenance task for instance and that leads to increased maintenance cost over the whole life cycle of the equipment.

2.2 PAC programing

The PAC constitutes the core of each machine. It contains the behavior of the machine. When is it needed to open a valve or start a pump? Return conditions for alarms and events.

The behavior of the machine is reflected in the code that is downloaded to the PAC. The PAC programing tool is object oriented so the code can be structured in automation functionalities.

Automation functionality serves a specified purpose. A closer look at a pump control should highlight this approach.
The main functionality of a pump control is to pump a fluid through a pipe. To fulfill this requirement the flow of the fluid to be pumped needs to be measured. The measured value or process value will then be processed into a manipulated value that controls the pumping performance. As a result of that the PAC increases the frequency of the drive to increase the flow if the flow gets below a defined value. Further if the stop (start) button is pressed while in manual mode the drive needs to be stopped (started).

In addition to this core functionality, the pump control also needs to generate alarms and events for unscheduled and scheduled maintenance and provide the data that needs to be recorded to track the performance of the pump control.
Now what seemed to be a simple engineering exercise has become a lot more complex than initially estimated.
In order not to have to re-program that behavior every time such functionality is needed the software to program the PAC enables engineers to define function blocks (from now on stated as FB). These are references that can be instantiated every time the pump control is needed.

2.3 SCADA Engineering

The SCADA is the human machine interface that enables an operator to operate and view the plant performance. The four core functionalities of a SCADA system are:

- Communication to the plant floor data (PAC)
- Visualize and operate
- Record data
- Display alarms and events

Today's SCADA systems comes with a lot of features like web services, redundancy, user management, load balancing, multi-language support etc… This paper will not handle all these subjects.

In order to visualize the plant, the SCADA application is structured into areas. An area can be of geographical nature (i.e. a fresh water tank in Istanbul). The structure criteria to be used for a SCADA application for segmentation purposes or segmentation strategy depend on the type of solutions that the manufacturer is targeting. A water plant would typically be segmented in geographical regions and a final assembly line in an automotive plant would be segmented in functional areas (break filling station, wheel alignment).

Once the segmentation strategy has been defined, we can define and allocate the functionalities to the created areas. On that level we define how many automation functionalities are needed and the area they should be allocated to.

If we come back to our pump control that would mean that:

- A graphical representation of the pump is needed.
- An interface to configure the pump (what is the flow that I want to maintain in the pipe)
- Alarms and events for the pump control needs to be displayed
- Flow, running time and other key performance indicators needs to be logged in a database and displayed in a trend.
- An interface to control the pump (simulate, manual/automatic mode…)

If we consider all these aspects it becomes clear that the pump control as a SCADA object requires extensive engineering. It's not only the drawing of the graphical interfaces or faceplates it's also the navigation between them, the grouping that needs to be done around the alarms to only show the alarms related to the specific pump control, log the key performance indicators and link the faceplate to the plant floor controls.

The reuse of SCADA objects is therefore essential. It means that a reference with all the described features has to be developed. The instance of that reference will reflect the specific pump control in the application and enable engineers to reuse the object. Therefore a SCADA software package has to be object oriented.

3. MAPS IN THE VALUE CHAIN

To have a common understanding on the notion of value chain, we'll use the definition provided by Michael Porter.

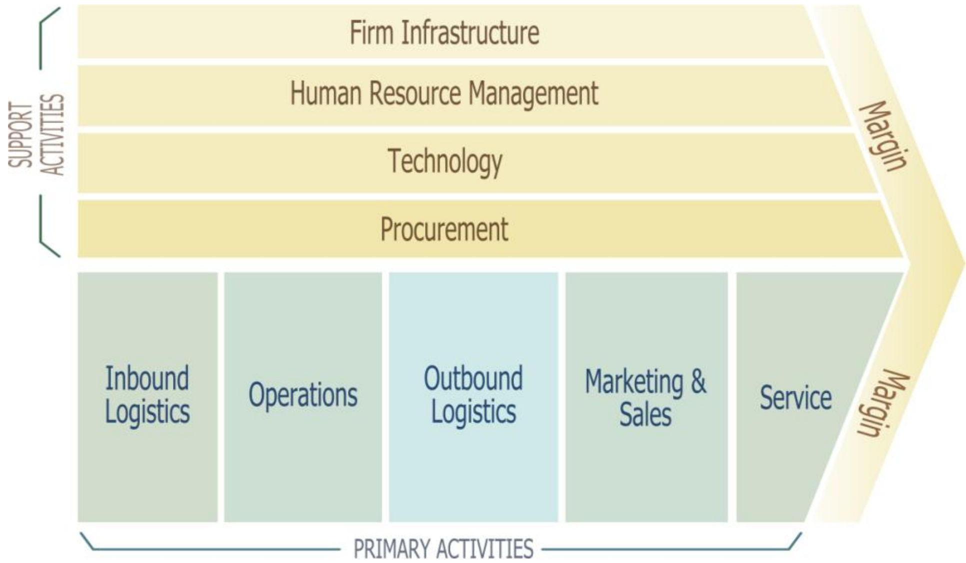

Fig. 1 Porter's value chain [1]

Porter's value chain is structured in primary activities and support activities.

The primary activities are those that stand in direct relation with the value to be produced. The support activities provide an output that support the primary activities.
I.e.: an engineer that works on a water project is acting in the primary value chain since his work directly affects the project. The head hunter who acquired that engineer for the company is acting as a support activity since.
Another approach to differentiate these two activities is based on the cost allocation. If the cost of an activity can be directly allocated to the process issuing the salable good then this activity is of primary nature. If it can't be directly allocated it's of supporting nature.

The three engineering disciplines described in chapter 2 are allocated in the support activity technology and the primary activities operations and service.

3.1 Support Activity: Technology

The technological or research and development department of a plant manufacturer is responsible for delivering the references of all the automation functionalities. That means the electrical drawings, the FBs for the PAC and the objects for the SCADA system.

The cost generated by that department cannot be allocated to any salable good since the output of that department can be used among many projects (or salable goods).

3.2 Primary activities: operations and service

These two departments are working tightly together in organizations that deliver turnkey solutions for the water industry. While the operations department is responsible of producing the desired salable good (the equipment for water plant) the service department is responsible for its maintenance. Both departments focus on the understanding around the technology and are strongly customer orientated. In some organizations both departments are merged.

The operations department will use the result of the technology department to produce the needed equipment. They might customize some of the objects provided by the development department to fit the specification provided by the customer. All three disciplines might be affected by the customization.
An important task of this department is to commission the equipment. The commission on site is critical since it involves many changes that are reflected in the electrical design, the PAC program and the SCADA system. These changes can result in a longer commissioning process and that means that the whole time schedule is affected. Therefore change management plays a key role while successfully commissioning the equipment.

The main role of the service department is to maintain the equipment. That can be done when a specific event occurs (a defect) or just following a schedule. In order to do that the service department needs the same tools as the operations department and documentation that is up to date. The quality of the documentation has an impact on the duration of a service task.

The cost generated by these two departments can be directly allocated to the salable good (the water plant). We can therefore define them as primary activities.

4. HOW MAPS UNIFIES THE DISCIPLINES

Chapter 2 described the engineering disciplines involved in MAPS while Chapter 3 described how these disciplines are spread across an organization. Unifying the engineering disciplines means that the engineering tools across the organization have to interface with each other while being used in different departments.

The purpose of MAPS is to provide a consistent set of results at every life stage of the machine. That means that all three disciplines reflect the same engineering status. That means the PAC programing tool, the SCADA software and the electrical design package interfaces with each other and passes the changes made in one tool to the other two. This is valid for the complete life cycle of the Solution.

The output of one discipline affects the other two. If our previous pump control is replaced with a pump with an additional pressure control in the electrical design then that means that the FB in the PAC program needs to process the pressure value and that the SCADA needs to display that value, log it to a database and trend it. This change has a quite noticeable impact on the engineering effort.

4.1 The Master discipline

What is the master discipline? While engineering a solution all three disciplines start in parallel. At a given time, any discipline could be affected by a change that impacts the other two disciplines. Therefore the Master is the one where the changes are made. Therefore any of the three tools should be able to invoke changes in the other two software packages.

To fulfill that requirement changes can be inserted in MAPS and invoke changes in the other two systems.

As an example we could use an electrical drawing file to generate the initial MAPS project. That would then create the needed instances of the FBs in the PAC and the needed objects in the SCADA application and link these objects to the instances of the FBs in the PAC.

A further example would be to replace a functionality with a more advanced one in MAPS and have the changes reflected in all systems. This scenario is very frequent during commissioning and leads to many inconsistencies in the documentation.

While doing that change in MAPS the electrical drawing becomes updated or points out that the documentation needs to be updated. A separate list in MAPS is updated immediately to reflect the wiring of the objects.

So the answer to the initial question is: every of the three software packages should be a master when necessary. Therefore changes should only be triggered by the users affected by the changes and not automatically.

The operations department would use the objects available in the library to engineer their solutions. They can make sure that the solution they provide is consistent. That means the PAC program, the SCADA system and the electrical drawings reflects exactly the same content.

4.2 The right objects.

The previous section assumed that we have the right set of automation functionalities for our solution. The development department is responsible for delivering these functionalities.

In MAPS the development department has the possibility to create its own intellectual property. That means create their own functionalities and provide them to the operations department in a common library. The development department can act as a service supplier. While inserting these new functionalities after testing to the common library they insure that the operations department can process orders a lot quicker and provide an increased quality.

5. CONCLUSIONS

While unifying the PAC programming, the SCADA engineering and the electrical design MAPS doesn't only contribute to an increased efficiency but also to an increased quality.

Taking advantage of that approach means that the right functionality for the right solution must be available. These customized functionalities can be delivered by the development department.

However the development of customized functionalities is a resource consuming task. But the cost for that should not be allocated to a specific project since the functionalities can be reused in several projects.

MAPS doesn't come with an own electrical design software, PAC programming software and SCADA software. It uses already available and accepted software on the automation market. The intention behind MAPS is to create an interface that connects the three mentioned software packages.

In order to increase efficiency it's essential not to do task twice or even three times. The output of a process should be reusable and automatically interpreted by all affected processes. By doing things twice the probability of producing a mistake is doubled.

REFERENCES

[1] http://en.wikipedia.org/wiki/Value_chain