IS SMARTER ALWAYS BETTER – ADOPTING NEW TECHNOLOGIES

Richie Murray and Nigel Stevenson – Ergo Consulting Limited

ABSTRACT

The control system sector within the water and wastewater industry is constantly changing. New technologies, techniques and equipment are continuously pushing the boundaries of what can be achieved. However, from this questions can arise such as, "should all these new techniques be adopted?" and "do they add value?".

For many non-electrical engineers the negative aspects of the new technologies may not be immediately apparent, as often only the positive aspects are detailed within product brochures. The purpose of this paper is to examine some of the technologies and equipment within the latest market trends and reviews their positive and negative aspects. This will allow clients to make better decisions on whether or not these new technologies actually add value to the business. If a new technology is not implemented correctly or for the wrong reasons it can actually become a cost to the business.

There are a significant number of new technologies out there, however this paper will review four topical items namely communication systems, packed plants, SCADA graphics and VSDs.

Communication systems within motor starters have been around for many years. This has led to a slow industry push towards removing the traditional hardwired systems and replacing them with complete communication based systems. Whether or not these systems add value to a client will depend heavily on the technical skill within their organisation. Communication systems require a much higher level skilled technician to install and maintain. For clients who have these skills in-house a communication based system can provide a huge cost saving. However, typically within the water and wastewater industry these skills are still not common place and therefore the hardwired plus communication approach has been taken. This approach places fundamental control on a hardwired system with auxiliary information being provided by the communication system. This set-up allows low skilled technician to still debug and fault find fundamental issues within the motor starter and improvise temporary solutions if required to make the equipment function.

The concept of purchasing a complete packaged plant can be very appealing to many clients. These packages can significantly reducing engineering and construction time resulting in cost savings. However, whether or not these systems add value to client depends on how they package is integrated into the control system. Generally these packages are provided with their own level of autonomous control and therefore can be limiting when trying to connect external monitoring or control functionality. This aspect can therefore quickly reduce their value as clients may require additional instruments or control circuitry in order obtain the level of integration they require.

The concept of Human Centered Design (HCD) has been around for many years. When applied to SCADA systems the approach would appear to go against the traditional graphical improvements. HDC has been designed to focus on the human element within the control system and therefore only emphatically display the abnormalities. This approach is intended to move away for the "smarter" flashy 3D graphics and colours. Whether or not these systems add value depends significantly on the system size and familiarity of the system. As it also the interface point into the control system, how the system looks and operates is significantly affected by each individual personal preference.

The variable speed drive (VSD) has become a very common site within the water and wastewater industry. There is no doubt that they can provide great control functionality and energy savings when used correctly. However, the concept of value can quickly be overcome if a VSD has been selected for the incorrect reasons. In these cases the VSD is not used to control speed but is only there as a "just in case". This is because the installation of a VSD involves significantly more cost than a direct on-line or soft starter.

KEYWORDS

Motor starters, communication systems, human centred design, variable speed drives, packaged plant

1 INTRODUCTION

The control system sector within the water and wastewater industry is constantly changing environment with new technologies being developed and marketed every day. This ever changing platform can make it difficult for clients who are trying to create a standard, modern, appropriate, stable and overall cost effect environment for their business. When evaluating many of these new technologies, clients need to look past the sales "smoke and mirrors" pitch to determine whether or not the new technologies are really suitable and will add value to their business.

The following paper has been written to provide clients within the New Zealand water and wastewater sector an objective view towards a few of the latest technologies. There are a significant number of new technologies out there, however this paper will review four topical items namely communication systems, packed plants, SCADA graphics and VSDs. The pro's and con's shall be detailed for each new technology and an overall review of what value it can provide to clients.

2 HARDWIRED VS COMMUNICATION CONTROL

2.1 SUMMARY

For many years the traditional motor starter has been operated and controlled by hardwired connections. The premise of this type of control is that each signal provides one control function i.e. run motor, run feedback or fault feedback. This type of control first started out with the use of simple switches, which then developed to relays and then to PLC's. Most motor starters used today are monitored and controlled by a PLC system. This control often requires three to four digital inputs for run, fault and auto feedback, one digital output to start/stop the motor, one analogue input for current monitoring and one analogue out for speed control (if operating a VSD). For some clients this basic level of control can be limiting for their operation. In order to capture additional signals more wiring will be required. These clients may wish to monitor kWh, number of starts or temperatures to better refine the operation and maintenance of their equipment.

Communication systems have been around for many years and have become a standard option on most motor control equipment. These communication protocols allow clients to extract significantly more data out of their motor starters than what would be typically feasible over hardwired connections. Over the years a number of standard industry protocols have been created. One of the first and most basic is Modbus, this is widely support by most manufactures. Other common protocols used are Profibus, ControlNet, DeviceNet, DNP3 and Ethernet.

A number for manufactures now promote dedicated communication based motor starters as the way of the future. However, just because communication systems are smarter doesn't always mean they add value. Each client must review this internally to find out what their needs are and what is best for their operation. One of the most important aspects to consider when reviewing this decision is the skill level of their operators and the maintenance staff. Due to the sophisticated nature of a communication system a higher skilled technician is required when setting up or fault finding. This can be particularly important during early morning faults or short shutdown windows. Often these faults will also require the technician to have intimate knowledge of the exact clients system which they are working on. This can often be problematic for clients who use external maintenance contractors or do not possess the required skills internally. With a hardwired system an improvised solution can often be installed by most technicians to make the equipment operate until a higher skilled technician is available.

A significant benefit of a communication system for external maintenance contractors is the remote diagnostic ability. Theoretically a technician can "connect" remotely to the device and determine what has failed prior to leaving for site. This then allows them to bring the correct equipment, tools or parts to site and reduce the probability of multiple visits.

The next item which should be considered is the level of control which is actually required in order to operate the process correctly. For many clients the basic level of control is adequate for their motor starters and therefore they would not actually benefit from the additional information. In some cases this additional information could just cause unnecessary complication for operators. For some clients, the data is vital for their maintenance and optimising plant performance. This is particularly relevant when considering efficiency savings.

The third item to consider is of cause cost. Depending of the size of the starter a communication based control system can have an overall lower capital cost compared to a hardwired system. This is through a reduction in the required cables lights, switches and relays. It will however incur a higher technician cost for installation and maintenance. In these cases the ideas of economies of scale is important. The set-up cost of a communication based control system may not be economical for a signal VSD.

The use of entirely communication based control systems has not been widely utilized within the New Zealand water and wastewater sector. Typically most clients have opted for a balanced approach. This involves operating key motor control functionality via hardwired connections and only using the communication system for auxiliary information. This allows clients to get the best of both worlds. Additional information can be provide if required while still allowing low skilled improvised solution to be installed if a fault occurs at 2am. Manual control should also still be allowed for as a last line of defence (particularly important in critical systems). This means it will often not be possible to eliminate hardwired controls completely.

2.2 PRO'S

A summary of the positive aspects for dedicated communication based control systems are:

- Reduction in installation capital cost (i.e. less relays, terminals, lights, etc.).
- Provides a physically simpler installation (i.e. less cabling, switches, lights, etc.).
- Eliminate multiple failure points within the motor starter.
- More information can be displayed for the operators on SCADA system.
- Remote diagnostics are available allow operators to know the fault before arriving.

2.3 CON'S

A summary of the negative aspects for dedicated communication based control systems are:

- *Starter units can incur a higher capital cost to include a communication module.*
- Issues and limitations can occur when trying to set up communication between two manufacture's equipment. It is also not recommended to use a mix of protocols as protocol converters can introduce another failure point within the system.
- Higher skilled technician required to fault find problems.
- Additional programming required during commissioning.

3 PACKAGED PLANT

3.1 SUMMARY

The idea of "Smart" devices has become a household name over the past 5 years. As a result many OEMs are providing the 'packaged plant' which is designed to operate autonomously and make the operators life easy. These systems have the ability to provide clients with great cost and time savings by reducing engineering and commissioning time.

These packaged solutions typically consist of one or more smart devices (i.e. PLC or VSD) and a number of local instruments. Based to a pre-defined program developed by the manufacture the smart device(s) will use the information provided by these instruments to respond to the process system accordingly.

Whether or not these systems add value to a client depends on the system they are being integrated to. For systems which do not operate as part of a wider control system they are brilliant (i.e. farming). However, for clients who already operate and standardised control system, the integration of these packages can be problematic if the provided equipment differs from the client's standard.

A problem that can occur relates to the clients requirements for data collection. In many cases it is not possible to obtain the signals from the local instruments without undertaking modification to package, either by duplication of signals or changing the PLC. In both of these cases, doing such modification can void the warranty and is therefore often not undertaken. A common solution which is implemented is that clients will place their own instruments beside the packages instruments to provide that remote monitoring functionality. Once this is done, it significantly reduces the value of purchasing a package due to the level of duplication.

Another common problem comes from trying to incorporate remote control functionality into the package. Clients who operate a high level of remote monitoring functionality are often expecting a high level or remote control functionality. As many package systems are designed to be autonomous any remote control functionality can very difficult to implement. In many cases any remote control functionality must be implemented by "tricking" the packages local instruments or control system into responding in a desired manner. Therefore, this also reduces the value of purchasing a package by have to create a secondary control system.

The provided smart device and predefined program can be both a blessing and a curse for clients. It is often not possible to change the manufacture of that provided by the OEM. This can cause problems of clients who use a different control system. Fault finding and maintenance can become an issue as it requires knowledge and spare parts for multiple manufactures.

3.2 PRO'S

A summary of the positive aspects for utilizing packed systems are:

- Reduction in installation capital cost when the package is not being incorporated within a wider control system.
- Reduction in the engineering and programming time as this has been undertaken by the manufacture.

3.3 CON'S

A summary of the negative aspects for utilizing packed systems are:

- Remote monitoring of instrumentation or status from the package.
- Incorporating remote control functionality.

4 HUMAN CENTRED DESIGN

4.1 SUMMARY

The idea of Human Centered Design (HCD) has its roots in semi-scientific fields such as ergonomics, computer science and artificial intelligence. The HCD approach focuses on the human element, particularly the way operators access information from a control system. The objective is to emphatically displaying abnormalities and faults only, with the aim of better alerting operators to their presence.

Modern control systems can be extremely complex. As a result SCADA screens and switchboards have become increasingly cluttered. Competing colours and movements can make systems difficult to monitor, with critical

information easily overlooked. This has also been compounded with the advances in computer processing power and graphics which have allowed modern SCADA systems to become very dynamic.

The HCD approach removes all unnecessary colours, movements, and 3D graphics. HCD SCADA screens predominantly use neutral colours, such as greys and browns. Only abnormalities and faults are displayed in bright colours. This allows them to stand-out and quickly catch an operator's attention.

Whether or not HCD adds value to a SCADA system is very subjective and must be evaluated individually by each client. For many people the idea of using the latest graphics and 3D animations is without question the smarter thing to do. However, if alarms are missed the consequential failures and costs could be significant.

A common example which is used to illustrate the potential for errors to occur while operating a complex control system is the incident which happened on the 28th March, 1979 at the Three Mile Island nuclear power plant in Pennsylvania. The cause of the incident was never conclusively determined, but experts, official bodies, and the media all blamed a combination of operator error and bad control system interface design. Operators where swamped with indication lights and alarms and therefore could not clearly identify what issues had arisen and how to correct it.

The HCD approach can also be applied to motor control centres. Debate has raged for years over what colours should indicate when a motor is running. In some industries red is used (to indicate danger) but green (like a traffic light) is used in others. Technically both approaches can be correct. However without a universally accepted colour code, the subjective interpretation of the operator comes into play. The HCD approach can help remove possible confusion.

4.2 PRO'S

A summary of the positive aspects for utilizing a HCD control system are:

- Graphics are simplified.
- Helps operators and maintenance staff only focus on the important information.
- It is possible to create and standardise a common interface across industries.
- Reduces the chances of misinterpreting any alarms.
- Removes the subjective interpretation of what each colour means (i.e. does

4.3 CON'S

A summary of the negative aspects for utilizing a HCD control system are:

- It is different i.e. not what people are expecting when viewing SCADA screens.
- Normal plant functions are more difficult to observe.

5 USE OF VARIABLE SPEED DRIVES

5.1 SUMMARY

The variable speed drive (VSD) has played a significant role in increasing the efficiency of many plants. They provide clients with a high level of flexibility when operating their motors, as exact operating variables can be determined during the commissioning phase. This therefore allows projects to proceed when only an approximately motor size is known. Provided the installed motor is larger than the approximated size, then the speed of the motor can be adjusted until the required duty point is met. VSDs are also invaluable to clients who wish to operate a dynamic system to provide a constant flow, level or pressure.

There is therefore no doubt that VSDs can add immense value to clients when selected and operated in the correct manner. For these clients any of the additional costs required to operate a VSD are quickly overlooked due to the benefits they provide to their system. However, for applications were a VSD has been used and is never intended to vary away for a fixed speed this value can quickly become an additional cost. The use of a VSD should be clearly considered for each application.

One of the most noticeable additional costs for installing a VSD's is to do with its housing. Although VSD are rated up to IP54, the water and waste environment is very harsh on them. It can significantly reduce their lifespan. It is therefore best to house VSDs within a dry and clean environment. Heating and ventilation are also key consideration for any installation. VSDs can produce significant heat when installed in confined space such as an unventilated switchboard or room. This type of environment can cause the units to overheat which can lead to premature failure of internal electronics. These installation requirements can make the installation of VSD more expensive than a DOL or soft starter.

The next significant cost when using a VSD is the electrical and hardware required to mitigate harmonics and EMC issues. Harmonics have become a significant issue for power authorises in the South Island and as a result have led to the introduction of much tighter connection requirements. These now require all VSDs operators to provide significant levels of harmonic mitigation. For many of these requirements the use of the low cost AC or DC chokes are no longer acceptable, as they do not reduce the harmonic current enough. As a result higher cost active front end VSDs or site wide harmonic mitigation is required. The most common cost associated with EMC is the use of screened cable. There are expensive and in order for the cable to be effective correct glanding, bonding and earthing must be used. These requirements can often get overlooked.

5.2 PRO'S

A summary of the positive aspects for utilising a VSDs are:

- Allows the process to altered and refined after it has been installed.
- Variable speed drives can be used as complete motor starter (no additional switchboard/housing).
- Manual controls built-in (however these are not always simply to use).

5.3 CON'S

A summary of the negative aspects for utilising a VSDs are:

- Cost (purchase, installation, cables)
- Harmonics
- EMC interference
- Cooling

6 CONCLUSIONS

It is hard to globally define the value of many of these new technologies. Their value ultimately depends on the requirements of each client.

Based on our experience within the New Zealand water and wastewater section our recommendation for the technologies detailed above are:

- Undertake the balanced approach to motor starter control. Completely hardwired system limit the amount of information available and completely communication based systems to still not widely supported by the majority of technicians.

- The use of packaged plants within large facilities (i.e. treatment plants) is manageable. This is because the control system of large facility is often much more advanced and has the ability to interface too many other control systems. The use of packaged plant at remote sites can be problematic as small data collection units can have interfacing limitations.

- The use of HCD based SCADA is a completely subjective for each individual client. There is great merit in the idea from a purely control system perspective.

- Provided a VSD has been selected for the correct reasons (i.e. to provide dynamic control), all costs involved with their installation become justifiable.

GLOSSARY

AC	Alternating current
DC	Direct current
HDC	Human Centered Design
OEM	Original equipment manufacturer
PLC	Programmable logic controller
SCADA	Supervisory control and data acquisition
VSD	Variable speed drive

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