Making automation work - A case study

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Abstract

The automation of a cane sugar factory is an exercise that can easily result in disappointment for the end user. This is especially so in locations where specialist skills and resources may be in short supply. This paper is based on a case study at Worthy Park Estate Ltd. Jamaica who undertook an ambitious automation programme starting in 2001. Currently it is the most highly automated sugar factory in the West Indies and has recently completed the automation of a new distillery consisting of a pot still with two retorts. The methods used to achieve the effective results are discussed. Some areas that have been found to give problems in other locations are highlighted.

¿Es posible que la automatización funcione? – Estudio de un caso particular

La automatización de una fábrica de azúcar de caña es una experiencia que fácilmente puede llegar a decepcionar al usuario final. Esto sucede, particularmente, en localidades donde tienden a escasear los conocimientos técnicos específicos así como los recursos. Este trabajo se basa sobre los resultados de un estudio en Worthy Park Estate Ltd., en Jamaica, donde se emprendió un ambicioso programa de automatización comenzado en 2001. Hoy en día es la fábrica de azúcar más altamente automatizada en las Antillas, además de haber completado recientemente la automatización de una nueva destilería que consiste de un destilador (alambrique) con dos retortas. Se analiza el método utilizado para lograr resultados eficientes y destacan al mismo tiempo, algunas de las áreas que causaron problemas en otras localidades.

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Why automate?

• Establish automatic control of all or part of the process.
• Produce a better product with less waste.
• Establish consistent control of bottleneck areas so as to maximise throughput.
• Reduce costs (figure 1).

What often happens!

• System works until specialists leaves site
• Local staff unable to maintain system
• Is kept running on manual
• Looks good but does very little
• Disappointing results

Things that can go wrong

The system works well until the specialist leaves site, but then ceases to function as more and more areas are bypassed.

It is often found that local staff has little appreciation of the technology being used. Are unable to correct simple problems because
they do not have the required equipment or know how to use the software.

Operational software is sometimes deliberately written in a complicated and confusing manner, in order to discourage end user maintenance. This results in systems being run in manual control or on bypass operation after a short period of time.

To the casual visitor computer screens look high-tech, but can hide a multitude of poor engineering on the plant.

The end result is disappointment, frustration, and a reluctance to consider future automation projects even when there is a large potential gain to be made (figure 2).

**Project planning**

- Involve local staff of all grades at an early stage
- Ensure an intimate knowledge of the process by the control system designer
- Remember the basics
- Explore innovative solutions
- Modify existing plant where necessary
- Adopt a modular approach where possible
- Keep it simple

The importance of close involvement of local staff cannot be overstressed. If a control system is to be successful it must have the full backing of both operational and maintenance staff.

The advantages of a proposed system must be carefully sold to local staff “It is going improve the product sugar, make your job easier, and save some labour” works much better than “It will replace you”.

It must always be remembered that if a process operator does not want a system to work, then it probably won’t work, no matter how hard you try and how good the equipment is.

One of the most frequent reasons for control system failure is that the basic installation of process mounted equipment is incorrect. Basic good installation practice must be followed.

If a part of the process can not be controlled manually, then it is unlikely that it will be successfully controlled automatically. Existing installations may require modification to make them suitable for automation.

Often reliability is sacrificed to lower cost when process transmitters are being considered. A control system must be reliable if it is to be trusted.

Keep systems operationally simple. If the process operators have to follow complicated procedures to use the automation, it is less likely to be accepted. Innovative solutions to control problems can be built into software but should not complicate operation.

A modular approach to automation should be adopted when possible. It is much better to start on a small area (e.g. evaporator station) and prove that station before carrying out the automation of other sections. As additional sections are added the feasibility of a central control room increases. The system chosen obviously must be capable of supporting any future centralisation.

**Project Implementation**

- Develop and install system using local staff as far as possible
- Commission system - Continue training of staff
- Assess results - make modifications if necessary
- Train staff (maintenance and operational)
- Prove one section before embarking on the next

Ideally local staff will be trained to carry out the major part of the programming of the control system themselves. They then will have an intimate knowledge of the programme structure and be able to carry out minor alterations without incurring the expense of third party consultation.

Prior to, and during commissioning full training should be given to operational and managerial staff. Ignorance leads to fear/non-acceptance.

Involve all grades of staff in assessment of the system performance. Carry out any necessary modifications as a result of the assessment.

Continue training of staff so that their knowledge enables them to spot the early warning signs of control system malfunction.

Prove one section before starting on the next. This particularly important on the first section of an automation project where equipment reliability may be an unknown factor.

**Do**

- Involve and use local resources
- Use a modular approach
- Emphasise the benefits of the system
- Training is the key to successful automation

Using local staff and resources helps to build a strong team spirit and ensures that the project is “Ours” not “Theirs”. Employees will take a keener interest in successful implementation.

A modular approach to automation builds confidence. Emphasise the benefits of the system and that jobs will become easier. Training of local staff leads to success.

**Don’t**

- Let operators become screen watchers
- Ignore feedback from end users
• Let operators lose touch with the process
• Clutter the screen with too much information (figure 3).

There can be a tendency for operators to become screen watchers and develop the idea that sugar is made in the computer and what goes on outside the control room is not their concern.

Ensure that the operators keep in close contact with the process and look at what is actually happening in the real world. Feedback from end users is most important and can lead to a better process understanding for future developments.

Do not place too much information on a single screen. Only the important parameters should be shown in figures others should be shown graphically by bar graphs. A quick glance at any screen should be enough to determine if all is well with the process, flashing graphics can highlight any off normal readings. Other data should be easily accessible if required.

 Pictures can lie!
• Can you trust the data being displayed?
• Don’t believe all you see

Process input data to a computer controlled system can be easily manipulated. It is possible to completely change the appearance of trends by selecting unnecessarily long filter times and update intervals. An unstable control system can be made to draw a seemingly smooth trend of the process. Sometimes this is done deliberately to disguise incorrect controller tuning or other inadequacies with the control system and can be difficult to spot. The provision of basic local indicating instrumentation should be considered in critical areas.

Digital data can also be manipulated and falsely represented on the screen. Cross check displayed data against process measurements on a regular basis.

Case study : Worthy Park Estate – Jamaica

Brief history of Worthy Park Estate

First sugar planted 1710. First Rum Produced 1741.

Currently Worthy Park produces sugarcane on 1200 hectares, mills 210,000 tonnes of cane annually of which 90,000 tonnes is produced by the Estate (the remainder purchased from farmers) with an average annual sugar production of 24,000 tonnes and 7,000 tonnes of molasses. On the agricultural side, the Estate produces on average cane yields of 83 tonnes per hectare and 10 tonnes of sugar per hectare. The Worthy Park sugar factory’s efficiency has been rated No. 1 in Jamaica every year since 1968.

Automation program – main stages

2001 Planning and training for project implementation
2002 Juice treatment, evaporator, and molasses conditioning controls
2003 Cane feeding, mill lubrication, semi automatic control of pan stage
2004 Granulation pan fully automatic control
2005 Billet cane feeding controls
2006 Distillery automation – Believed to be the world’s first pot still with two retorts to be automated.

Listed below are the highlights of improvements in key areas of factory operations since 2001.

1. Billet cane feeding control
The cut to mill time of billeted cane (figure 4) has reduced from an average of 12 hours to 3 hours. It also has produced a much more constant feed to the mill, resulting in approximately a 6% increase in milling rate.

2. Cane feeding controls
Reduced down time due to cane chokes by nearly 25%.

3. Mills and gearing lubrication control
Reduced lubricant consumption by nearly 20%.

4. Juice treatment control
Before automation under and over liming was prevalent, resulting in poor clarification and sugar quality. After automation lime application was steady contributing to better clarification and sugar quality. Lime usage has been reduced from an average of 1kg/tonne cane to 0.8kg/tonne cane.

5. Evaporator station control
The evaporator station being undersized is the main bottleneck of the factory. Before automation syrup brix was inconsistent ranging from 54 to 60. After automation (with no increase in heating surface) the
normal brix achieved has been 60 to 61 for the last three years.

6. Pan boiling and molasses conditioning control
Sugar quality has improved from being amongst the worst in Jamaica to the best.

“A” Massecuite to “A” Molasses purity drop improved from 18/19 to 20/21.

“B” Massecuite to “B” Molasses purity drop improved from 19/20 to 22/23.

Total Purity Drop (syrup to final molasses) Average 54.06/53.16, this includes three years operations with Polysaccharide problems. The purity drop for the current crop to 6th Feb 2006 was 55.5.

It must be noted that at the same time as the pan stage automation was carried out there was also a major change made to the boiling scheme.

7. Distillery operations: Blending control for fermentation
The volume, brix, and pH of wash used to feed the fermenters is closely controlled, resulting in consistent and predictable fermentation media concentrations. These combined features dramatically improved the ability to manipulate the molasses blending process. The control of fermentation media in molasses fermentations is critical to enhance fermentation efficiencies, or to manipulate the consen-generic profile produced in fermentation.

Consistency control of distillation process
The volumes of batch feed, products and by-products can be accurately determined. In-line and composite alcohol concentrations of all distillates (heads, high wines, low wines, and rum) are also be accurately determined. This allows for almost total automation of the distillation process with the system automatically switching to the different phases, this automatic switching to the different phases based on reliable readings of process parameters allows for consistency of the distillation process, by eliminating human interventions and errors. The consequence of this is consistency of the distillates; a key quality control requirement. The constant recording of operating parameters allows for detailed knowledge of the conditions in the distillation process. This has been found to be very useful for a batch-type distillation system where the temperatures, alcohol concentrations, and to some extent, pressures in the system are constantly changing. The insight into what is happening in the process has guided, and will continue to guide process development. Steam usage versus calculated energy requirement guides the energy utilisation of the still (figure 5). This helps the energy conservation effort.

Conclusion
The above results show what can be achieved by correctly applying the powerful tool of automation in an old established factory. It can not be stressed too strongly that automation alone can achieve very little. It has to be applied using sound sugar technology and engineering principals. Whilst considerable improvements have been made so far there is no room for complacency. Frequent revision of operating results can highlight further potential areas for improvement.

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