Assessing the Value of Emulation

Emulations have been used to successfully debug and start-up hundreds of manufacturing systems, saving significant time and money on new or expanded production lines. In fact, emulations typically cut the time required to achieve project success criteria in half. Coupled with the benefits of enhanced operator training, emulation has become best practice for high-performance companies and their facility partners.

Haskell has used Brooks Automation's AutoMod Simulation Software since 1999 to help debug and optimize programmable logic controls (PLC) for integrated, high-speed packaging and material handling systems within the food, beverage, pharmaceutical, and consumer products industries. This method of emulation allows us to better manage the risks inherent in installing or modifying complex production lines, and has been proven effective as a tool for bringing complex projects in on time and on budget.

Potential risks companies are exposed to in starting up new or modified packaging may include:

- Longer than anticipated line start-ups
- Too much wasted product used to debug the control system
- Service technicians on site for too long
- Lots of change orders for post installation work
- Late in meeting customer demand

More Work Prior to Start-Up

The value of emulation can be summed up in one statement. "Emulation lets you have access to the line earlier than was previously possible." Through modeling technology, engineering and operations personnel can see the system running in the office, well before start-up in the field. This kind of early access means more phases of a project can be conducted on parallel tracks as opposed to taking up time on the project's critical path. Figure 1 shows how the logic debug and training can be done earlier in a project, along with equipment installation and other phases.

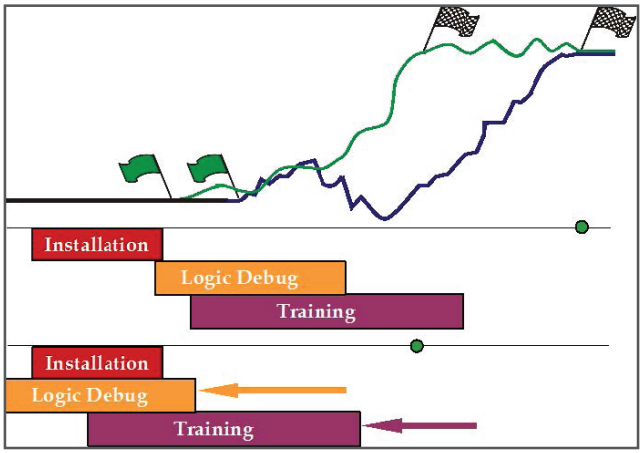

Figure 1 - *More phases of a project can now be done in parallel and are no longer on the critical path.*

The logic debug has traditionally been a high-risk phase on a project's critical path; it's the last checkpoint when everything else is ready to go. Having early access to the system helps to dramatically reduce the risk of delays and cost overruns during debug, by allowing much of the logic debug phase to be taken off the project's critical path (see Table 2).

Relay technology was one of the early forms of technology used to debug logic for a system; however, almost all of the logic had to be debugged after installation. With the emergence of PLCs, about 50% of the logic for a complex control system could be debugged up front. Using an emulation model, 80% of the logic now can be debugged off the project's critical path.

Conducting more of the debug phase with an emulation model allows the optimization of other project controls and reduction of related risks. One is the risk of change orders due to miscommunications on system controls. For example, it is now possible to conduct a logic checkout to review how controls are programmed and working before start-up of the system.

The emulation model's visual interface gives Haskell's customers the ability to quickly validate that controls are designed to their specifications. During this review,

Advances in Control Technologies	Debugged Off the Critical Path	Debugged On the Critical Path
Relays	25%	75%
The Emergence of PLC's	50%	50%
Using PLC's with Emulation	80%	20%

Table 1 - *How we feel the emergence of new technologies has affected the amount of the logic debug time that has to be done on the critical path.*

the project team can often pinpoint new opportunities to better optimize the system. Because the installation phase is underway during this time, customers can take advantage of these opportunities without impacting the project schedule.

In addition to gaining greater confidence in the overall control system, the project team also can identify and make physical control system changes — such as adjustments to a photo eye's location — before installation. This saves time during the start-up phase and reduces the number of change orders to mechanical and electrical contractors.

Shorter and Less Costly Start-Ups

When a project enters the start-up phase, the number of people working on the project goes up dramatically — and with it, the risks associated with managing their time. For example, a certain amount of standing-around time is usually expected during start-up while control problems are addressed. Machine service technicians and controls engineers are constantly waiting on each other as they work to get the product through the system. While the controls engineers work on debugging the conveyor logic, service technicians can only do so much on the machines without the product running.

This scenario is another in which emulation generates significant advantages. Given that emulation can reduce the time it takes to get product running through the system by as much as 80%, service technicians have less conveyor control problems to wait on.

Figure 2 indicates that debugging logic controls off the project's critical path can also reduce the start-up phase by about 30%, which helps to significantly reduce project costs. For instance, service technicians' costs go down due to shorter and fewer visits. There is also less wasted product and material, because fewer debug runs are required to bring the system up to full production levels.

When Haskell began to use emulation technology, our engineers did not adjust project completion dates to account for reaching full production status earlier than expected. As a result, we were able to provide our customers with a large amount of additional product to help meet market demand.

Case in point: For one of our first customers using emulation, Haskell was able to help produce an additional 100,000 cases of product as a result of the project reaching full production levels four weeks early. On another project, we were able to facilitate the production of an additional 350,000 cases of product when the project reached full production levels six weeks ahead of schedule.

Having gained significant expertise in emulation since that time, Haskell is now better able to predict how much earlier systems can come up to full production

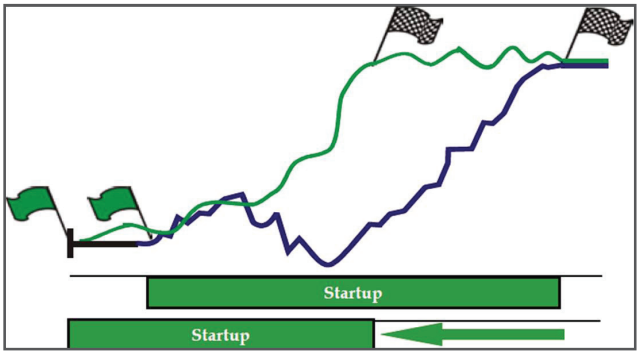

Figure 2 - *The start-up time is typically reduced by 30%, when the conveyor and system control logic are debugged with an emulation model in advance.*

levels. These projections help our customers get their product to market faster, and with a greater level of certainty.

Better Long-Term System Performance

The final phase of Haskell's start-up process is operator qualification. To complete a project, operators must run the new or modified system for two weeks at the originally agreed upon performance specification. This protocol is a fundamental part of Haskell's project management philosophy, because we know that effective operator training helps to ensure better long-term performance of the system.

Emulation plays a vital role in this process as well. Because emulation can provide access to the line during installation, operators can start training and practicing using the system early on, as opposed to waiting for the completion of the installation and start-up phases.

In addition to generating more time for training, the emulation model allows for more interactive, hands-on learning. The system control screens, or HMIs, can be connected to the emulation model so operators can practice operating and troubleshooting the system using the actual hardware. The result is like a flight simulator. Operators are asked to do specific things, like start-up the conveyor system or stop the motor, and they have to do it with the same interface screens as those on the system.

We refer to this type of training as the "no fear factor." Operators can press any button and see what happens without risking their jobs. Because emulation gives them a much better feel of the system in advance of start-up, operators take ownership of the system faster and are much more proactive about taking it over from service technicians.

The final way that emulation helps to contribute to a system's long-term performance is by helping controls engineers optimize the system. This optimization occurs way back during the office debug phase, after the controls engineers have finished debugging the basic system functionality. They can then use the model to better optimize the system logic, by running more complex tests to ensure that the logic is working efficiently.

Controls engineers also can use the model to test different ideas on how best to run the system. This allows them to test different optimization protocols while minimizing risk. In many cases, controls engineers are able to use emulation to discover new ways to produce more throughput, and as such, generate more profitability for the customer.

Conclusion

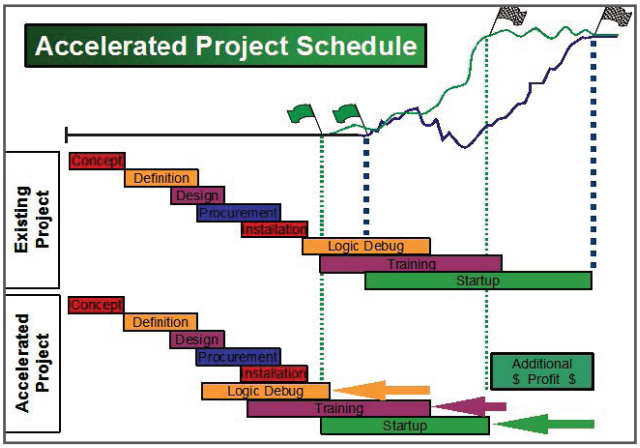

Figure 3 - *The accelerated project schedule shows how emulation and other tools allow a project to be brought in ahead of schedule.*

Many considerations are involved in making the decision to use emulation on a capital project. At Haskell, we encourage customers to study the beneficial results we have generated using emulation as a tool during the construction and testing of manufacturing systems. (See Figure 3). We believe the use of emulation technology will become a standard practice within the high-speed manufacturing controls industry within the next five years. As such, customers would be well advised to consider putting this technology into place in upcoming capital projects.