MAKING AUTOMATION A TEAM PLAYER IN BIOPHARMA MANUFACTURING

Making automation a better partner is critical for the human-machine system as a whole. **Jim Ball** and **Kristen Pham** outline strategies to achieve this in biopharmaceutical manufacturing, with relevance for all sectors.

I nervously set the adaptive cruise control at 65 mph and hovered my foot over the brake pedal, prepared to slam on the brakes as soon as I got too close. As the car in front of me slowed down, I felt that pull of my body moving forward. My car was slowing down to match the lower speed. *"Hey, it worked, that's great!"* I thought, *"but what about side streets? At what point would this automation fail?"* I repeated this series of micro-experiments over the next few weeks until I was comfortable and familiar with the workings, capabilities, and limitations of this new adaptive cruise control. It took me quite some time to learn to trust this new technology.

This same sort of apprehension shows up in our work when new technology is introduced, and it often forces us to shift our thinking in how we go about our job. Our organisation recently upgraded our biopharmaceutical manufacturing control software to a software with more automation capabilities, allowing operators to do fewer manual tasks. In

a manufacturing context, these tasks include opening valves, and recording information such as activity start times, product information, flow rate calculations, and people involved in the tasks.

It took time to realise the benefits of a more automated system. This was partly because of end users' hesitation to trust the automation to complete tasks they have always manually done themselves. How could we improve our automation so that it would function more like a team partner to our operators in an integrated system (Christoffersen and Woods, 2002)? Here are three strategies we deployed to overcome this challenge:

1. We needed a way to test and learn in a safe environment.

The production environment was not an appropriate environment to test, so we had workshops where operators walked through the procedures with automation engineers in a simulation environment. This gave operators and automation engineers an opportunity to ask questions about various situations about what is done in the automation. For example, we could assess confusion in interpreting prompts, determine where logic loops were needed, or identify places where tightly coupled operations led to loss of positive control. Other ways we have tested in a safe environment include mock runs to test the interaction with both the automation and the equipment to test operation and interface functionality, and process validation.

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2. We needed to automate with humans in mind.

Our purpose for implementing automation is to perform difficult tasks and reduce cognitive and physical workload on the operators.

a. We needed to design the automation in a way that operators are aware of what the automation is currently doing, the reason why it's in that current state, and what it will do next (Billings, 1996). This typically leads to more information on the interface which could lead to more clutter, increasing the risk of confusion between different modes. Our goal is to find a way to display all necessary information on the interface without it being too cluttered.

b. Confirmation prompts in the automation can help the operators maintain positive control and give them the authority to make decisions in the process. However, the prompts must be easy to understand but also detailed enough to give the operator the ability to make an informed decision.

c. As new automation is introduced, changes in the sequence of tasks will require new explanations of how things work in the real world to understand this new sequence. Without the proper training or shift in these 'mental models', operators may not be equipped to make decisions during off-normal events (Lee et al., 2017). This can cause stress for the operator and lead to distrust in the automation. By helping our end users see the effects or actions that the new automation introduces and how it is different from the past, we can mitigate these risks.

d. Alarms should be meaningful and give sufficient detail about the problem that caused the alarm to activate. Having too many nuisance alarms that are not meaningful and are usually ignored can make it difficult to know if it is a 'true' alarm that needs to be attended to immediately before an issue arises (Norman, 2013).

3. We needed to have designers collaborate with end users.

Designers may have one vision in mind while end users (operators) may have another. The system must be designed to support the user's needs instead of forcing the user to adapt (Christoffersen and Woods, 2002). To understand user needs, we observed operators interacting with the automation interface to perform their tasks in the manufacturing suites. This diversity of perspectives from a cross-functional team led to improved design and better end user performance. The designers learned what problems the operators were having, and what they would like to have on their interface to make their jobs easier. As a result of this collaboration, we saw an increase of commitment to the change and higher level of ownership by the end users.

Automation can enhance the end user experience and improve process control, and the interaction between the operators and the automation cannot be separated. The experience of introducing this new technology was not an effort to replace our people with automation, but rather an effort at making the automation a better team player in the complex and interdependent work that we do.

Much like a new member of the team, our operators needed to discover new ways of working, and adapt to the quirks, intricacies, and even surprises, of the new automated partner. And much like a new partner on the team, this improved automation partnership allows us to provide high quality products for patients.

References

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