Digital, **Digital Everywhere...**

Everywhere we look, whether in print or online, there are articles about digitisation, digitalisation, digital twinning, digital transformation and plenty of TLAs (Three Letter Acronyms). I find that many of the stories are either long on fluff or full of technical jargon, neither of which provide practical information someone can use in their day-to-day role. What is one to do?

By Stephen Cherlet - FarStar Consulting

In this article, I will not go through all of the definitions, how to build a strategy, or define a road map – there is lots of good material available already. Within your strategy, and roadmap, you should have some proof-of-concept (PoC) projects. After one, short definition, I will jump straight to some concrete of examples of real-life projects in the valve industry.

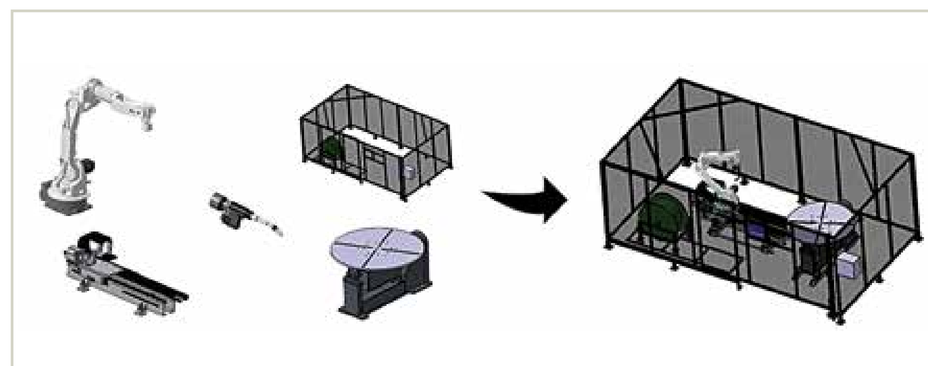
I recently came across some articles and presentations by George Westerman, who has an enlightened and practical approach to the topic of digital transformation.

“Digital transformation is the process of using digital technologies to create new — or modify existing — business processes, culture, and customer experiences to meet changing business and market requirements.” - George Westerman, MIT principal research scientist and author of Leading Digital: Turning Technology Into Business Transformation.

Simply put, use software and data to help improve products and processes.

Process Validation and Improvement

Some time ago, I was involved with a team working on programming robots to perform stellite deposit (hard-facing). At the time, robots were mostly programmed very manually using handheld devices attached by umbilical cords. They wanted to come up with a way to use some existing CAM (Computer Aided Manufacturing) tools to improve the programming process, but they needed validate the resulting movement of the robot. Rather than do the trials with a real robot, we all agreed to build a model of the process and run everything as a simulation. The crew put a lot of effort into the project which had multiple parts:



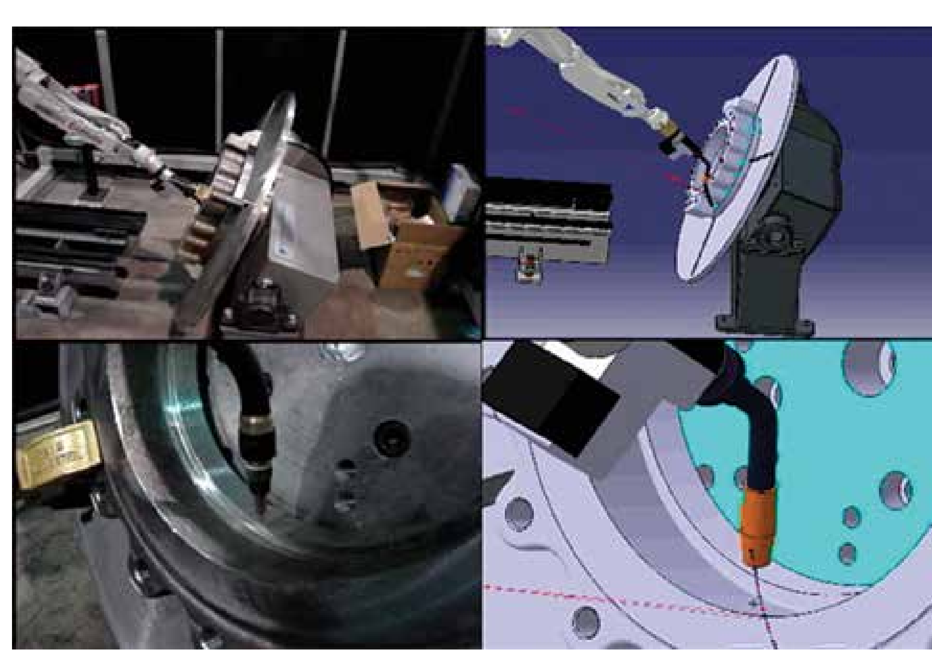
- 3D model of the workpiece (delivered as a CAD model from design)
- 3D model of the robot, positioner, etc. (developed using a machine tool building option)
- In-house translator from G-code to Motoman code

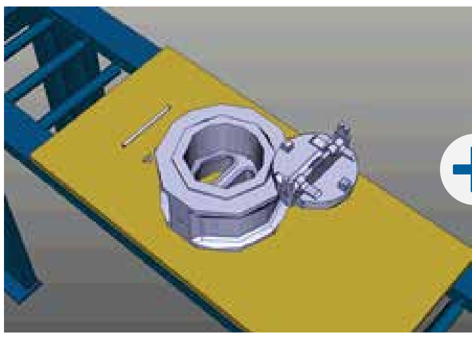
All the individual design elements were brought together into an assembly that included the proposed safety fencing. This allowed us to validate the robot’s range of motion inside the enclosure (collision detection).

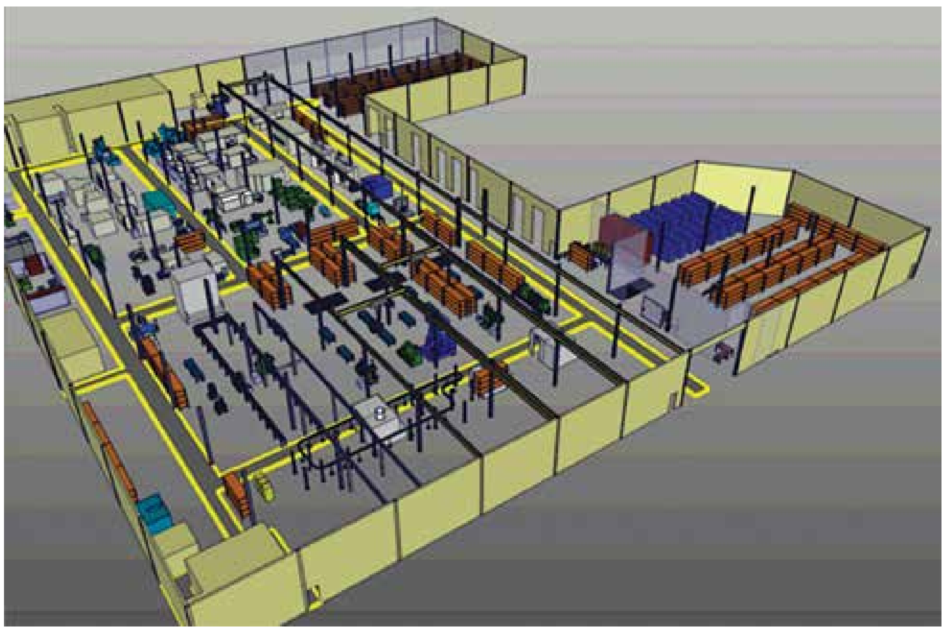
Once everything was brought together from the equipment side, the workpiece was added, and the simulations were run. The total programming time was reduced from hours to minutes, movement was validated with respect to torch path, and no collisions between equipment and safety barriers detected. The team did a fantastic job of recording the actual torch movement in real-life and then positioning the video adjacent to the simulation video output on the monitor. The still image below doesn’t do justice to the result.

Plant Layout

For those readers of a certain age, I am sure you will recall the days of doing office and plant layouts using 2D flat drawings, possibly hand drawn, and paper cut-outs of the furniture or equipment. If we were lucky, we had colored carboard cut-outs. This was fine for high level position and checking that everything would fit into the space allowed. Simply, we wanted to avoid trying to put 10 pounds of potatoes into a 5-pound bag. With modern tools, we can do much better. While working out the layout for a facility expansion, our team decided to invest some additional efforts in preparing a 3D layout. The project was in its early stages and we wanted to build on some of the experience gained from the process validation project. The software tools included the same machine building option from the CAM software and added the 3D structural steel module. This let us build up the plan in 3D based on the 2D structural/construction plans from the architect.







As in the first project, everything builds up from individual models into assemblies. On the next page, you can see the actual product components and the assembly conveyor line, all of which add up into the process line including test rig and paint booth. All the process lines and other equipment, like NC (numerically controlled) machines, add up to the entire factory

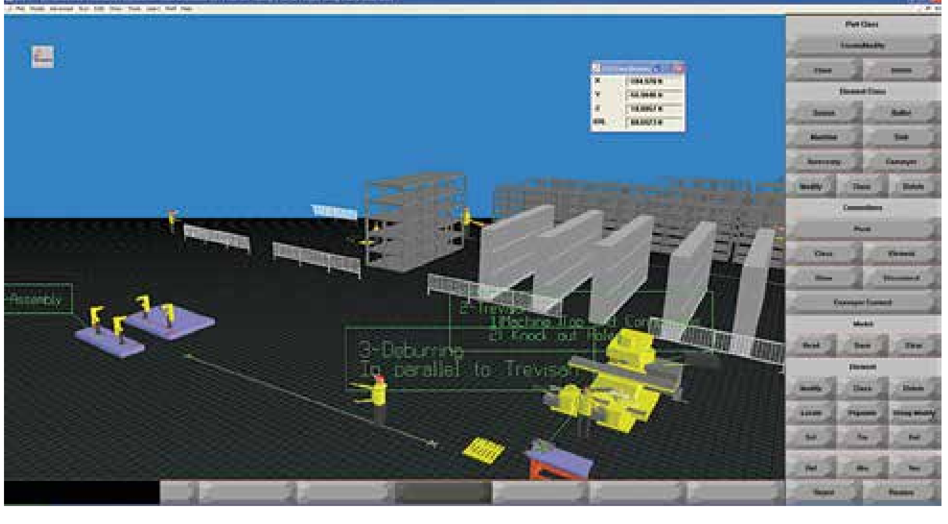
It looks like a lot of work, but this was accomplished by a university engineering student over the course of the summer. With the model in place, we were able to try various layouts and keep copies of them for comparison. Travel distances could be validated. Both horizontal and vertical spacing could be checked. For example, we could see if the crane heights were sufficient or if the rising portion of the chip conveyors, from an NC machine, were going to interfere with other equipment. In the end, everything was installed as planned and without obstruction, or need for "rework".

A secondary benefit was that various visualizations could be produced. The parts on the assembly conveyor could be used in a part assembly simulation. Prior to the finish of construction, we produced a fly-thru (like having a camera on Superman's shoulder) through the facility which we showed to staff, and customers, as part of a communication plan.

Value Stream Simulation

The next step involved modeling, like we have just seen, and then adding data to drive production output/throughput simulations. Using software part of the same CAD/CAM suite, from Dassault, we chose to prepare a detailed value stream map for a proposed work cell. This line had been running for many years, decades, based on a traditional "functional" layout. Machine tools in one section, grinding in another; assembly separate from the machine shop, and so on. The goal was to locate raw material near the machines, next to assembly and test. Ahead of doing this, we wanted to be able to answer questions about travel distance reduction and output changes. It's not that difficult in a high-volume, low-mix environment. Our situation was that of low-volume and high mix.

With the simulation tool, we were able to create a spreadsheet matrix of the more common product variants along with their setup and cycle times, along with typical lot sizes. We didn't take advantage of some of the more advanced capabilities of the tool which included lot size variation and probabilistic machine failure. Since we didn't have the knowledge and skills in-house to set-up, and run, the simulation tools, we did use outside resources who were experts. This saved a lot of time and frustration.



What was the result? We implemented the layout as modeled. Impressively, the travel distance from picking raw material to final test was reduced by 90%! Co-location of the equipment in, along with dedication to, the line drove most of the improvement. Re-locating raw material stores also helped significantly in terms of time and distance. Some process changes, mostly in machining, helped also. The end results included a 22% increase in PVA (production value added) ratio.

As a side benefit, due to the smaller lot sizes, we decreased fork list traffic in the area. Parts could be moved on small trolleys. The lot size of (1) meant weight was no longer an issue, and the travel distance was often a matter of feet (across the aisle).

Conclusion

It is best to have a strategy and a plan, but I believe that sometimes you just have to do things. The key is to learn from the successes and failures, in equal measure and without blame, then use that to help properly structure your plans. Also, by doing a project, like any one of the above, you have something concrete to show people who may not understand, or be convinced about the value of, modeling and simulation.

The benefits, like the efforts, are cumulative. Start by modeling a machine, then a process, then a factory. Add data and then run simulations at any level. Typically, the models are reusable from CAD to CAM to simulation. The more you build, the easier the process becomes to expand the analysis via simulation. At the end of the day, for example, you can try more combinations and permutations of layouts, in less time, to arrive at a model destination.

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