Discrete Manufacturers Driving Results with DELMIA V5 Automation Platform
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DELMIA V5 Automation Platform Connects Simulation and Real World Production Control
Executive Overview

Fierce global competition is driving manufacturers to rethink their manufacturing strategies and methods. Dynamic customer requirements, shrinking product life cycles, increasing product variants, reduced product launch times, and pressures for profitability are not only driving the need for more lean, agile, and intelligent manufacturing operations, but also for improved manufacturing design capabilities. The emergence and adoption of next generation Digital Manufacturing (DM) tools are enabling manufacturing engineers to efficiently design and validate lean, agile, and intelligent systems before the product launches and production begins.

Dassault Systemes’ DELMIA V5 Platform represents a best-in-class DM solution set for manufacturers. The DELMIA V5 platform offers an integrated suite of tools that provide manufacturing process design, tool and fixture design, and factory and production system design through powerful 3D visualization and virtual simulation. The recent advance DELMIA has made in their V5 Platform with the addition of the DELMIA Automation Platform represents a major transformation enabling manufacturers to design, validate, and commission their production equipment. The DELMIA Automation Platform allows manufacturing engineers to merge virtual models of production equipment with automation and controls. This enables the complete validation of all controls logic and HMI functionality. This level of manufacturing process design and execution capability will help manufacturers compete in the intensely competitive global environment and execute “flawless” launches.

Many discrete manufacturers currently use DELMIA products to help them design effective manufacturing processes. Several of these discrete manufacturers are also assessing the use of the DELMIA Automation Platform to validate their control designs. And one of them, General Motors, is actually gaining a competitive advantage in using this technology for virtual commissioning.
Automation Simulation Comes of Age

Automation simulation is the process of modeling, evaluating, optimizing, and validating controls systems for automation equipment and systems in a virtual environment. This technology provides manufacturing and controls engineers an opportunity to ensure controls designs work before production starts.

Discrete manufacturers have understood the tremendous benefits of automation simulation for the last ten years, but they have not been able to deploy the technology successfully until recently. There have been three roadblocks preventing these companies from successfully using automation simulation:

- Automation simulation is very complex and requires precise modeling of the electrical and mechanical parts of the manufacturing system. In the past, it has taken significant engineering resources to develop the models along with a huge amount of accurate data to drive the simulations making automation simulation impractical to use on a large scale.

- Automation simulation requires that a PLC communicate with PCs and related factory software. In the past, it took excessive custom design work to get a PLC to communicate with a PC.

- Until recently, there haven’t been DM tools available to efficiently develop and utilize detailed models of the electrical and mechanical components in an automated manufacturing system.

Today, this situation has changed substantially. Standards, like OPC, have made communications between PLCs and PCs easy to implement. More importantly, suppliers like DELMIA now provide very powerful automation simulation tools that enable users to effectively and efficiently model, design, evaluate, and validate detailed electrical and mechanical systems. And lastly, manufacturers are beginning to integrate these automation simulation tools into their design process and controls architecture so they can efficiently utilize the technology. Clearly, automation simulation has arrived.
Discrete Manufacturers Driving Results Using DELMIA V5 Automation Platform

DELMIA V5 Automation Platform

The DELMIA V5 Automation Platform is a best-in-class DM solution set for designing and validating control systems. The DELMIA V5 Automation Platform allows manufacturing engineers to merge virtual modeling of production equipment with automation and controls. This enables the complete validation of all controls logic and HMI functionality prior to the start of production.

Smart Device Builder Module Provides Reusability

The control architecture for an automated manufacturing system consists of smart devices such as control panels, relays, circuit breakers, power supplies, and drives. The Smart Device Builder module enables controls engineers to efficiently build these smart devices for multiple controls applications in a virtual environment. Control engineers can also define parameters for any specific device. These parametrics include information such as the internal logic, bit parameters, and interface descriptions for a specific device. Additionally, the Smart Device Builder module provides the user the capability to store virtual devices in a Smart Device Library. This library enables engineers to reuse previously defined virtual smart devices (and related internal logic and parameters) multiple times, as they build virtual models of their control systems.

One of the most important features of the Smart Device Builder is its import capability. This capability enables engineers to quickly develop a new virtual smart device or sub-system by importing an existing virtual device or combination of virtual devices from an external hardware design file or the Smart Device Library and modifying them. The import capability not only saves engineers time, but also reduces errors because engineers start with a virtual model with the knowledge that it already works.

DELMIA provides tools so the controls engineer can take previously defined virtual smart devices from the library and assemble them into a virtual automation system along with control logic and a complete set of I/O. The device internal logic and parametric information is used to ensure the virtual devices function properly and properly communicate with other virtual devices. A controls engineer can assemble various virtual smart de-
vices from the library into a virtual main control panel or into a virtual group of smart devices on a network in a virtual cell as shown below.

The DELMIA V5 Automation Platform provides excellent tools to efficiently build virtual electrical smart devices and assemble them into a virtual control system. Manufacturing Engineers can also utilize DELMIA IGRIP software to build virtual mechanical models for robotic cell applications and several other software tools to build virtual mechanical models of conveyor systems and other production equipment. Reusing virtual smart electrical and mechanical devices in the virtual library is a key factor in gaining the modeling efficiencies needed to institutionalize the use of automation simulation at a company.
**Controlled System Simulator Module**

The Controlled System Simulator module provides users the capability to virtually simulate, debug, and validate a control system using the virtual devices and sub-systems from the Smart Device library that are configured for an application. Being able to simultaneously monitor four separate screens as the control program executes is invaluable for debugging complex designs. Engineers can watch the control logic execute on one screen and observe how the rest of the system is behaving on the other three screens. For example, an engineer can watch the HMI screen to ensure diagnostics and data are displaying correctly. Additionally, he can check the electric panel screen to ensure switches are turning on and off correctly.

**Ladder Logic, Virtual panel/HMI, and Mechanical Execution Visuals**

Finally, he can watch the mechanically driven equipment screen to ensure the processes are functioning correctly. All aspects of the control logic can be validated including manual functions, auto-sequence, diagnostics, and fault recovery. Engineers can utilize these screens to validate configuration and placement of sensors and other I/O in the control system to ensure they properly perform all intended functions.
Key Factors for Successful Deployment

Although the DELMIA Automation Platform has tremendous design and validation capabilities, manufacturers face several challenges to effectively and efficiently use the technology. Discrete manufacturers must take the following steps to fully exploit this DELMIA technology:

- Establish a common manufacturing controls architecture for the company. Standardized on an open communication network, such as DeviceNet or Profinet, as well as a set of competitively bid electrical panels and common controls components (devices) that utilize these open networks. Stabilize the architecture for at least a three to five year period. This standardization enables controls engineers to develop a set of virtual smart devices that will be reusable for these three to five years. This reusability of virtual smart devices provides significant time savings in developing the simulation models needed to virtually validate control systems in the plants.

- Leverage the import capability of DELMIA’s Automation Platform by taking a modular approach in developing the virtual smart device models. This modular approach consists of building the most basic virtual device models first, and then efficiently reusing them in specific configurations to build up more sophisticated virtual devices and sub-systems.

- Integrated the modules of the DELMIA Automation Platform with the company’s information and control systems architecture. This integration helps control engineers keep the virtual models relevant to the physical world and efficiently drive the automation simulations with accurate data.

- Integrate virtual validation tools into the company’s control design process so they can be routinely used on new, complex designs.

- Train key engineers so they thoroughly understand the company’s common controls architecture and DELMIA's Automation Platform. These engineers are virtual validation Subject Matter Experts, who support project engineers in the field with the validation of controls before deployment at a plant.
Example Development Process Using DELMIA V5 Automation Platform

This flow diagram summarizes an approach to integrate the DELMIA V5 Automation Platform into a company’s controls design process. The application ladder logic is developed and downloaded into a physical PLC. Commercially available electrical and mechanical design tools are used to develop application hardware designs and schematics, leveraging common component templates. These designs are digitized into virtual magnetics using the DELMIA V5 Automation Platform and into virtual tooling using the DELMIA IGRIP product for robotic cells and using other software products for conveyors and other equipment. The simulation is driven by actual ladder logic for the application. By integrating the automation simulation process into the company’s controls design process and controls architecture, the company is able to keep their virtual models relevant to the physical world, and efficiently drive the simulations with accurate data.
Excellent Results in Key Applications

The DELMIA Automation Platform product is being used to optimize and validate controls designs for robotic weld sub-assembly operations in automotive assembly plants. The typical weld sub-assembly cell consist of such devices as welding robots, welding fixture equipment, PLCs, HMIs, safety gates, safety systems, actuators, sensing devices, and automated inspection equipment. There is normally between one to ten welding robots in a cell and sometimes operators who feed panels to the first operation and stack or pack at the last operation.

Sometimes robotic weld assembly tooling and equipment is built new, other times it’s refurbished and re-used. The tooling and equipment might be built by a turn-key line builder or by an in-house tooling shop. And the tooling and equipment might be integrated at the turn-key line builder or on the floor of the plant where it will reside. For each of the above situations, engineers ensure that the controls designs are virtually validated prior to deployment. Engineers normally conduct this virtual validation at central office and then travel to the build shop or plant to validate actual tooling and equipment run-offs. These engineers are also fully engaged in the deployment and final debug at the plant.

Virtual controls validation has proven itself to be a very effective time and cost saver for robotic weld assembly applications. The DELMIA V5 Automation Platform technology has increased manufacturing flexibility and utilization of resources and significantly reduced tooling investment cost, deployment costs and lead times.

ARC has defined five goals that are important to effectively and efficiently deploy control systems at plants. The DELMIA Automation Platform is an enabler for controls engineers to meet these goals. The five goals and resulting benefits are:
• **Controls and systems ready prior to the start of production.** Pre-validation of electrical and mechanical designs enable faster production acceleration. Initial quality is improved because the production system starts out working like it is supposed to. Training is leveraged immediately because work is being done the right way without workarounds.

• **Debug time minimized at the plant.** Almost all electrical and mechanical designs are already validated. The majority of validation left to do at the plant is narrowed down to checking physical connections and software interfaces. This results in significant production launch workforce reductions at the plant, reducing engineering, direct labor, and travel costs.

• **All possible conditions tested before production starts.** Without automation simulation, it could take years to experience all possible combinations of scenarios that can happen on the plant floor. Automation simulation enables an engineer to iterate quickly through practically all scenarios.

• **Consistent validation processes used globally.** An automation simulation capability helps to reinforce common validation processes throughout the company.

• **Virtual training capability utilized.** Animation provided by automation simulation gives engineers an opportunity to experience the production environment and deal with various situations long before production actually starts.

The DELMIA Automation Platform is being used to enable engineers meet these goals. Discrete manufacturers now have the DELMIA tool set to deliver delivered working control systems to plants before production starts. Initial results at an automotive company show savings between two and three man-weeks during startups, smoother product accelerations, and improved initial quality and productivity. Engineering teams at this company are using DELMIA tools to find problems that would not be discovered for weeks after production started. The management team is leveraging the DELMIA Automation Platform to provide a consistent global process for validating control logic. The goal at the company is: No matter where control logic is designed, whether in North America, Europe, or Asia, whether by company people, tier ones or contractors, there is only one common con-
controls validation process - the one that uses virtual validation tools including the DELMIA Automation Platform.

The DELMIA Automation Platform has an outstanding capability to find logic and programming errors. This table represents a sampling of errors found in just one robotic cell application.

<table>
<thead>
<tr>
<th>Routines for robot to drop off to next cell missing in program</th>
<th>Extra gates in E-stop rung</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robot paths grouped which should not be grouped</td>
<td>Confusion between conveyor and station tags</td>
</tr>
<tr>
<td>Robot DLD problems</td>
<td>Incorrect out power for stations or output power not defined</td>
</tr>
<tr>
<td>Problems in Auto with cylinder repeatedly going from work to home</td>
<td>Problems with aliases for turntable and fixtures</td>
</tr>
<tr>
<td>Robots welding more than once in a cycle or not welding</td>
<td>Incorrect I/O assignments for second PV</td>
</tr>
<tr>
<td>Robot collisions</td>
<td>Incorrect data structures for fixture boxes</td>
</tr>
<tr>
<td>Robot and turntable collisions</td>
<td>Problems with decision codes</td>
</tr>
<tr>
<td>No operator E-stop in logic</td>
<td>Drop paths put in wrong programs</td>
</tr>
<tr>
<td>Problem with belt conveyor transfers</td>
<td>Confusion with clear of zone and robot clear bits</td>
</tr>
<tr>
<td>Problem with Telesis completes</td>
<td>No operator safety power</td>
</tr>
<tr>
<td>Outdated data structures</td>
<td>Robot clears not in robot program</td>
</tr>
<tr>
<td>E-stop with non-standard number missing in logic</td>
<td>Simulations came through with paths not found in eRWD</td>
</tr>
</tbody>
</table>

**Typical Error Checking with DELMIA Automation Platform**

By using the DELMIA tools, engineers are typically finding over 100 mechanical and electrical errors in logic, HMI, and drawings per cell. Two to three man weeks are saved during startup, saving thousands of dollars in engineering and production labor costs. Problems are normally found and fixed with minimal disruption to operations. Also, problems found in the field are solved more quickly since engineers can narrow them down to items such as physical connections, confident that the validated control code works. Scenarios not seen during startup can be simulated and corrected beforehand. All fault conditions can be tested, and all HMI screens will perform as expected at startup.
Future Expectations for Automation Simulation

The use of automation simulation is rapidly expanding into areas beyond robotic weld sub-assembly operations. A ripe area for the DELMIA Automation Platform is the validation of conveyor control systems in assembly plants. Historically, conveyor systems are never tested before installation at the home assembly plant because they are too large to setup off-site for testing. Consequently, significant debug time is required at the plant after these systems are installed, and the majority of this debug time occurs on the critical path of getting the plant started up. Control engineers at automotive OEMs such as General Motors are experiencing the same excellent results using DELMIA automation simulation tools for conveyor implementation and commissioning as well as simulating robotic weld sub-assembly cells.

ARC sees another opportunity for DELMIA in the future. As discrete OEMs start using virtual validation tools on a routine basis, they will eventually require turnkey suppliers to simulate and validate their designs prior to integration on their plant floor. The DELMIA V5 Automation Platform will most likely be used by turnkey suppliers and integrators on complex projects such as stamping press and CNC milling machine rebuilds to significantly reduce the time equipment is out of commission during the rebuild process.

The DELMIA Automation Platform will be an even more important asset to discrete manufacturers as they begin to fully understand the capability and benefits the DELMIA Automation tools have to help design effective control systems and efficiently validate those systems prior to production.

Conclusions and Recommendations

Automation simulation has emerged as a powerful tool to help manufacturers optimize and validate control designs for automation equipment. This technology ensures that the best manufacturing control designs are validated before production starts, conserving engineering resources and significantly improving product launch performance. Validated controls
designs for new vehicle launches result in improved initial productivity and quality and enable new and innovative products to reach the customer much faster.

The DELMIA Automation Platform is among the best-in-class automation simulation products available on the market. General Motors is using this Delmia technology to efficiently design and validate their electrical control systems in a completely virtual environment. GM is also in the process of integrating DELMIA Automation and DM tools from other suppliers into their control design process and into their manufacturing control architecture so that virtual smart electrical devices are accurately and efficiently developed and that accessible accurate information can drive the simulations.

Manufacturers should consider taking the following steps to evaluate the use of the DELMIA Automation technology for designing and validating their controls applications:

- Evaluate the DELMIA Automation products on simpler applications and assess the benefits. Utilize DELMIA resources to assist in this evaluation.
- Expand the use of this technology in the company and integrate the DELMIA tools into the company’s control design process and manufacturing control architecture.
- Utilize the technology on critical applications to ensure that designs are validated prior to production.
Analyst: Jim Caie

Editor: Dick Slansky

Acronym Reference: For a complete list of industry acronyms, refer to our web page at www.arcweb.com/Community/terms/terms.htm

API  Application Program Interface  ERP  Enterprise Resource Planning
APS  Advanced Planning & Scheduling  HMI  Human Machine Interface
B2B  Business-to-Business  IT  Information Technology
BPM  Business Process Management  MIS  Management Information System
CAGR  Compound Annual Growth Rate  MRP  Materials Resource Planning
CAS  Collaborative Automation System  OpX  Operational Excellence
CMM  Collaborative Manufacturing Management  OEE  Operational Equipment Effectiveness
CNC  Computer Numeric Control  OLE  Object Linking & Embedding
CPG  Consumer Packaged Goods  OPC  OLE for Process Control
CPAS  Collaborative Process Automation System  PAS  Process Automation System
CPM  Collaborative Production Management  PLC  Programmable Logic Controller
CRM  Customer Relationship Management  PLM  Product Lifecycle Management
DCS  Distributed Control System  RFID  Radio Frequency Identification
EAI  Enterprise Application Integration  ROA  Return on Assets
EAM  Enterprise Asset Management  RPM  Real-time Performance Management

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