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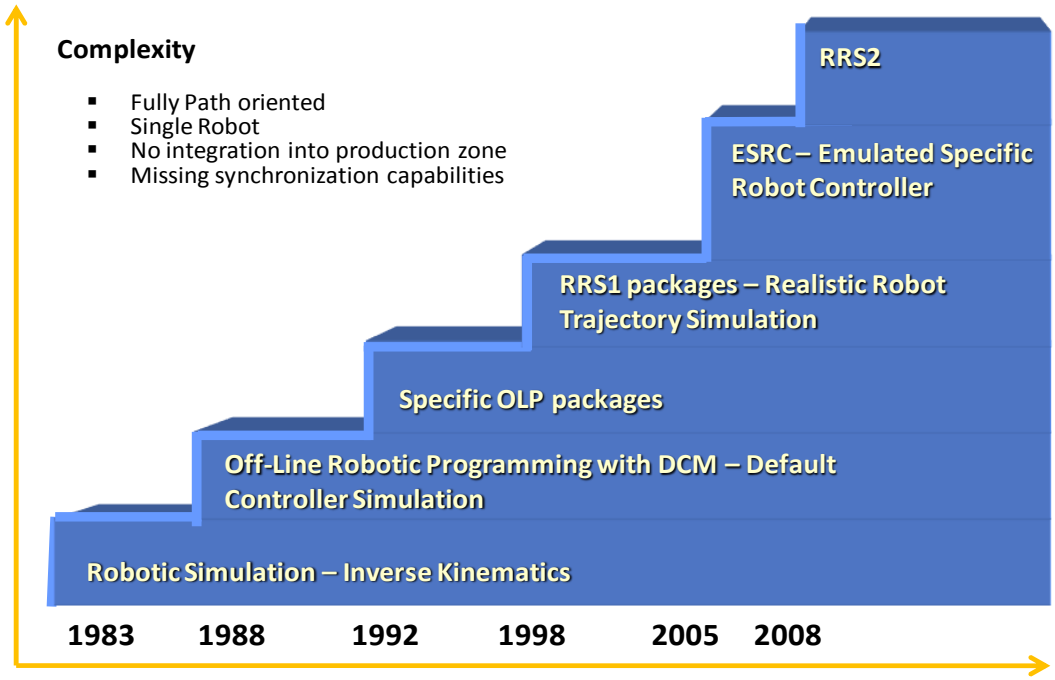
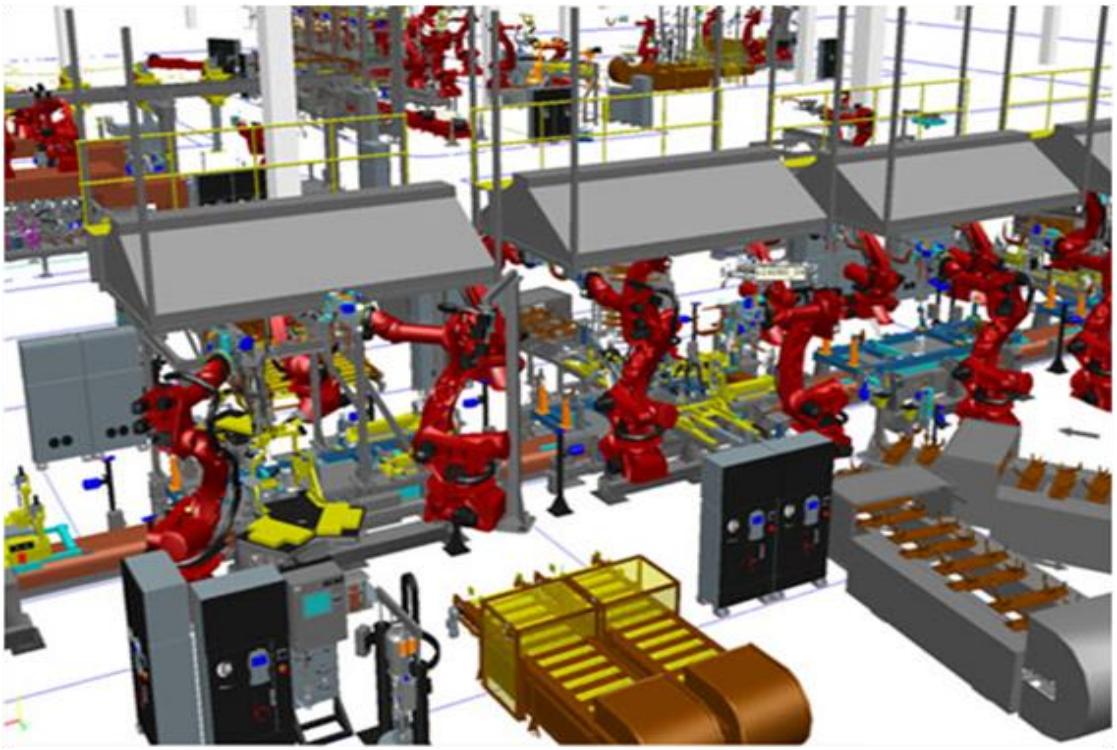
Siemens PLM Software's Robotics Simulation: Validating & Commissioning the Virtual Work-cell



History of Robotic Simulation and OLP



Complexity of Robotic Applications Requires Advanced Simulation

Executive Overview

Manufacturing operations are driven by a set of business imperatives that is forcing companies to implement technologies, processes, and practices that not only will enable them to compete and profit, but in some cases survive. In terms of having a product that will succeed in the market place, companies must be able to innovate. However, in terms of hitting the market window with the right product at the right time, companies must have manufacturing operations that are flexible, agile, and able to launch a quality product on time and cost effectively. Manufacturers, like Automotive OEMs and Tier one suppliers are looking for ways to move through their product launch cycles at much faster rates, and to deliver new models to a market that expects innovative products in timely manner and typically at reduced costs.

In order to hit the market window with the right product at the right time, companies must have manufacturing operations that are flexible, agile, and able to launch a quality product on time and cost effectively.

One of the evolving and emerging technologies that will enable companies to achieve the business imperative of timely and cost effective product launches is Digital Manufacturing. In the virtual 3D world created by the PLM technologies of solid model product authoring, digital mockup, and manufacturing process simulation, the final link to the actual production work environment is making the connection to machine control systems. It is one thing to simulate the machine tool, conveyor line, robotic work cell, PLC, clamping fixture, motors, drives, pneumatics and hydraulics systems; but quite another exercise to generate accurate information that is capable of driving control systems for all of this production equipment. This merging of Digital Manufacturing with automation is exactly where tools such as Siemens PLM Software's Tecnomatix robotics simulation are taking manufacturing in this final link to the factory floor.

The Siemens PLM Software Tecnomatix robotic simulation solution represents a technology that will be essential to manufacturers across all discrete industries where the requirement for agile and flexible production systems is mandatory. This technology addresses the need for virtual commissioning, one of the primary benefits and value propositions that the Automotive, as well as other discrete industries have recognized as indispensable to accelerating their product launches.

Business Drivers for Automotive and Discrete Manufacturing

Clearly, manufacturing across all industrial sectors is being driven by a new set of business imperatives. Agile response to volatile markets, drastic reduction of time to market, and high product variability are just some of the challenges facing manufacturers. Along with the need for constant innovation, manufacturers continue to focus on reducing the cost and time for producing the product, one of the single most effect means of remaining competitive. Moreover, reducing the time for product launch while optimizing manufacturing processes, will become even more significant as product lifecycles become shorter, product models and variants multiply, market prices erode, and global sourcing increases.

Manufacturers continue to focus on reducing the cost and time for producing the product, the single most significant means of remaining competitive.

Timely and Efficient Model Launches Are the Goal

The Automotive sector is indicative of an industry that is adopting Agile/Flexible manufacturing methods in order to remain competitive and drive down the cost of producing their product. North American car makers like GM and Ford, and European producers like VW and Daimler Benz are introducing new models targeted to niche markets resulting in very limited production runs (20-30K) that require timely and efficient model launches if the car maker is going to realize any profit. Production lines, workcell, and control systems must be designed, installed, and deployed in the shortest possible time and, even more importantly, work correctly and accurately with a minimal amount of test and validation.

While an on-demand business model for the automotive companies has direct impact on many aspects of the product lifecycle from product design to manufacturing process optimization, the structure and approach to the model launch represents an activity that will significantly affect the success and profitability of the new model. In order to respond to projected short model runs and already abbreviated production lifecycles, the production lines that are comprised of control systems, conveyors, robotics, welding and fastening systems, paint systems, metal forming and stamping, and factory networking infrastructure must be designed, installed, and commissioned in a very optimized and efficient manner.

The key will be the amount of time it takes to deploy, install, and commission new production lines for general assembly, paint, stamping, body-in-

white, and other assembly systems, and bring all of these systems up to production rate. Additionally, those engineering organizations involved will have to be accountable for the engineering resources expended, whether in-house or outsourced, to accomplish the model launch. Since the goal is to reduce the cost for new model launches, both time and resources have to be controlled while still satisfying the requirements for the production lines and the delivery of the new vehicles on schedule.

Value Proposition for Virtual Validation & Commissioning of Robotic Workcells

Clearly, the emergence of Digital Manufacturing (DM) tools that enable engineers to virtually design, validate, and commission assembly lines and workcells will be essential in the meeting the business mandate for agile and flexible production systems.

Next Generation Robotic Simulation Enables Virtual Commissioning

One very important component of these next generation DM applications are advanced robotic simulation tools that go far beyond earlier off-line programming applications. These simulation tools enable production engineers to virtually simulate, validate, and commission the entire robotic workcell environment. Today, a robotic workcell environment can be very complex, and could include multiple robots doing multiple tasks, complex tooling and fixtures, clamp automation and PLCs, conveyor automation, a variety of sensors, and even vision technology. Manufacturers are pushing the use of robotics well beyond the single task workcell to multi-robot gardens with the capability to build complex assemblies requiring high levels of synchronization and collaboration. This necessitates the use of advanced robotic simulation technology in order for production engineers to the meet the high level of complexity associated with these assembly and build requirements.

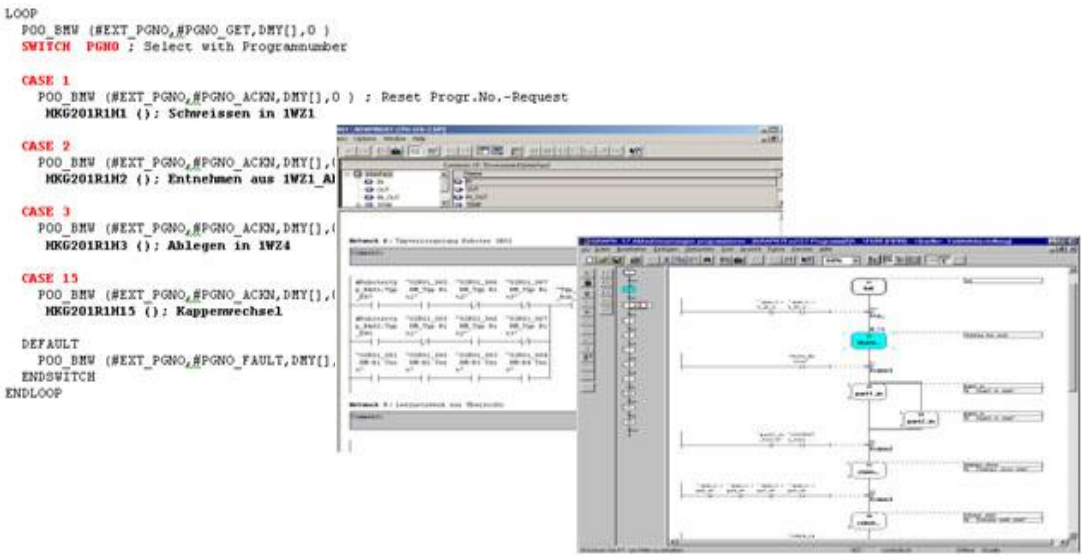
Virtual Commissioning directly addresses the Automotive OEM's need for faster production ramp-up and time to market, increased vehicle models, and modular plant designs all validated within the virtual environment

The automotive industry, as well as other discrete industries such as aerospace & defense and heavy equipment have indentified the capability to virtually commission their production systems and assembly lines as one of

the initial and most immediate benefits derived from DM technology. Robotic simulation represents a technology that has steadily evolved over time, and has become an essential tool for the automotive industry in the application of virtual commissioning. This directly addresses their need for faster production ramp-up and time to market, commonality of production processes across global operations, increased vehicle models, and modular plant designs all validated within the virtual environment.

Evolution of Robotic Simulation Technology & Off-Line Programming

Simulation plays a key role in the field of robotics, because it permits experimentation that would otherwise be expensive and/or time-consuming. Simulation permits engineers to try ideas and construct production scenarios in a dynamic, synthetic environment while collecting virtual response data to determine the physical responses of the control system. Simulation also allows the evolution of robotics control systems, which depend on random permutations of the control system over many generations. Technically speaking, robotic simulation results in off-line programming, but the real-world accuracy of the today's simulation applications allows for a fin-



Today's Robotic Simulation Handles Multiple Automation Instruction Sets

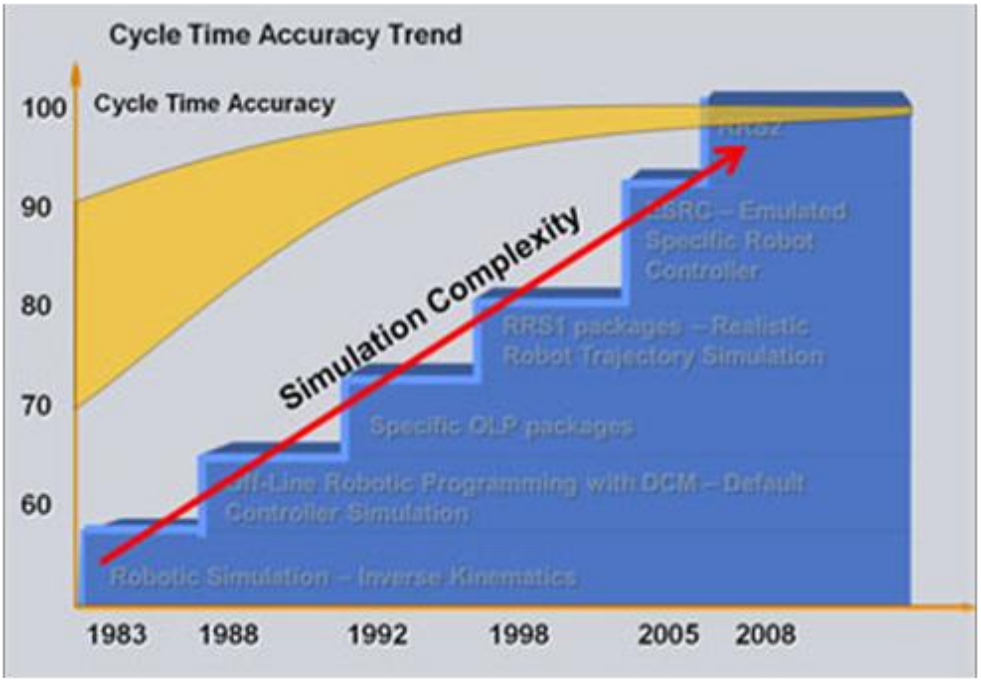
ished kinematic program that contains much more than just the motion path of the robot. In essence, robot programs have become much more

complex and now include a comprehensive instruction set that deals with many more variables present within the workcell environment.

Need for Product & Process Quality Drives Accurate Simulation Technology

Virtual simulation of production machines, robots, equipment, and of the overall manufacturing processes has increased in value to production operations directly proportional to the degree that the accuracy of the simulation tools has increased. Making the transition from the virtual to the physical world must be accompanied by high degrees of fidelity and accuracy in the simulation models that are applied to the real-world production systems. For simulation tools to provide real benefits in terms of validating a robotic workcell or any automated production system, they must be able to match, at a minimum, 95 percent of the physical process. Additionally, accurate design and simulation of device behavior should provide mechanical motion profiles and control logic, accurate off-line robotic programming, and accurate cycle time and interference analysis.

The manufacturing environment and the production processes that build the product have become increasingly complex. This can be attributed to the level of automation applied to the production processes, but addition



The Complexity of Robotic Automation Requires Accurate Simulation

ally, to factors such as multi-model assembly lines, and a heterogeneous environment of multiple robot brands, controllers, and automation equipment. This has lead to a situation where robotic simulation and offline programming has become nearly mandatory to manage and implement the complexity of the workcell and assembly lines while ensuring product accuracy and product quality. Next generation robotic simulation technology has proven to not only reduce process design errors, but to virtually validate the workcell through the generation of the process design thereby significantly reducing the time and cost of physical commissioning.

Siemens PLM Software's Robotics Strategy: Virtually Validating Physical Automation

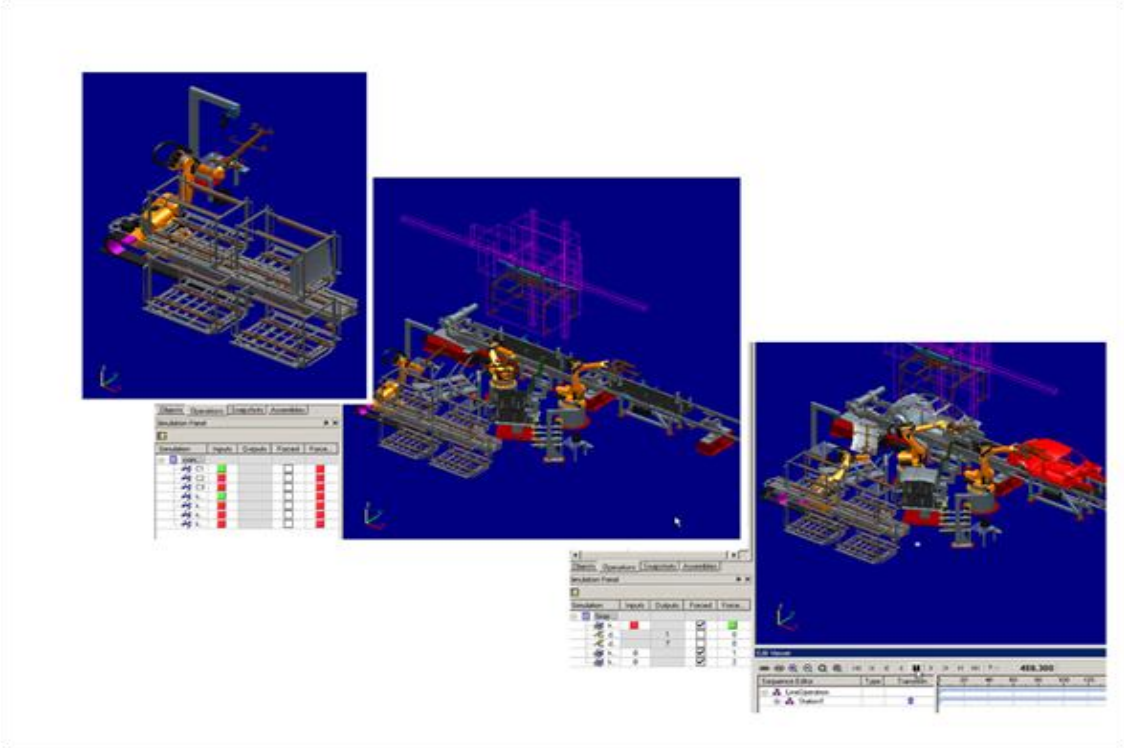
The Tecnomatix solution set covers the entire scope of Digital Manufacturing within the overall Siemens PLM Software product lifecycle solution set. Tecnomatix for manufacturing operations provides capability to design, plan, simulate, and validate the production processes for parts and assemblies, production equipment and resources, plant and production line layout, quality assurance, shop floor execution, and even human ergonomics. Moreover, the Tecnomatix Digital Manufacturing solution set functions in a very agnostic manner within the context of any number of product (automation) and plant combinations. Tecnomatix is fortified by a manufacturing backbone capable of a collaborative environment that ties together product, process, plant, and resource data models. This provides comprehensive and complete lifecycle coverage for the automation project, offering controls and manufacturing engineers and environment for planning and simulation with consideration of all mechanical and automation aspects.

Tecnomatix Enables the Next Generation Robotics Environment

One of the most significant advantages that the Tecnomatix robotic simulation solution bring to manufacturing operations and specifically to automotive body-in-white (BIW) and assembly workcells is a collaborative multi-user environment for robotic path and programming simulation. Moreover, as an integral component of the manufacturing backbone, the manufacturing/controls engineer is provided with a coherent product and

process data model that enables re-use, data management, and variable production scenarios.

The Tecnomatix robotics environment covers all aspects of the robotic production environment including planning, simulation, and validation of both manual and robotic operations from single robots to assembly zone level, and from concept through commissioning. In terms of the definition and implementation, the process begins with the basic concept and design of the robotic application, and then progresses through verification of concept to robot path planning and off-line programming (OLP) based on the virtual path simulation. This is followed by the synchronization of the robot path with other automation such as other robots, PLC controlled equipment, and safety devices. This process of virtual commissioning and



Tecnomatix Simulation Covers all Stages of the Automation Process

validation is then followed the physical build of the workcell, line, or robot garden. This virtual design, simulation, validation, and commissioning process can then be applied to the production environment requirements, from individual robot path, to robotic workcells, and to production lines and zones with the factory.

Advanced Realistic Simulation Enables Virtual Commissioning

Tecnomatix realistic simulation and advanced OLP technology give production operations engineers the capability to build virtual production systems based on real automation events. They are able to virtually model equipment such as conveyors, workstations, and controls, as well as the physical and logical interface and material handling operations that can occur between the components of workcells and production lines. Within this virtual modeling and OLP environment data can be shared between mechanical and automation design which significantly reduces the commissioning time and overall production systems ramp-up. Additionally, Tecnomatix simulation has the capability to work either individual workstation or in more complex production live conditions which offers a significant benefit to the interaction between multiple controls engineers.

A noteworthy example of virtual commissioning being applied to automotive production and proving its value is the BMW facility in Spartanburg, South Carolina where the X5 and Z4 models are produced. BMW needed a completely automated solution for joining the drive train and chassis. Typically, control software for a workstation of this complexity could not have been tested and commissioned until the workstation was physically built. Using Tecnomatix simulation tools a virtual model of the entire workstation was built, validated, and virtually commissioned before the physical workstation was built and automation implemented resulting in significant reduction in time and cost to launch.

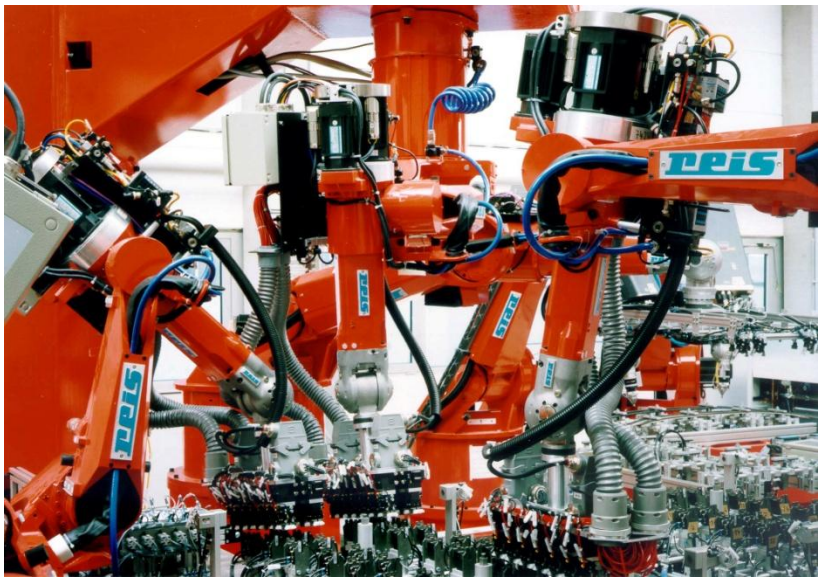
The advanced OLP features of Tecnomatix robotic simulation address the robot path control and signal exchange with other control systems within a workcell or production line environment. Tecnomatix has been evolving the technology of kinematics control and simulation for more than two decades. This began with simulation of reverse engineered inverse kinematics for time and motion profiles, comprehended OLP with default controller simulation (DCS) and culminated with Realistic Robot Trajectory Simulation (RRS1) a technology that enables a standardized integration of motion software for robot controllers with simulators by utilizing proprietary algorithms provided by the robot manufacturer. Hence, the motion software of any robot manufacturer can be integrated into the Tecnomatix simulation system.

In conjunction with RRS1, Tecnomatix developed an Emulated Specific Robot Controller (ESRC) technology that when combined with the 3D kinematics engine and robotic path physics capability of RRS1 produces

specific robot brand control planning. Since the typical production environment of any given manufacturer contains a variety of different robots, controllers, and automation equipment, simulation of these manufacturing facilities requires dealing with a very heterogeneous production environment. In essence, ESRC can deal with any given robot controller and their unique and proprietary robot control languages. This enables the designer/engineer of the production work environment to simulate and validate automation with multiple variants of controls and equipment utilizing a native control specific approach.

Reis Robotics Case Study

REIS ROBOTICS represents a leading company in robot technology coupled with manufacturing and production system integration. Their business model includes the development and the production of industrial robots and robot controls, along with the planning, design, and production of turnkey automation systems. Reis's expertise in manufacturing processes and factory floor production systems across multiple industries has established them as recognized leaders in systems integration for complex automation projects.



Reis Robotic Workcell Performs Complex Tasks

While Reis covers a range of manufacturing applications such as welding, cutting, lasers, plastic injection molding, casting, material handling, assembly processes and others, one of their significant strengths is being able to provide a complete robotic automation solution to meet their customer's specific product and production process requirements. That is, they are able to build a workcell or production system integrating their own advanced robotic technology along with any other automation and equipment required to meet the specific production methods and processes. In order to build and deliver complex and often difficult production automation projects to meet their customer's requirements, they must rely on state-of-the-art digi-

tal manufacturing simulation technology such as Tecnomatix Process Simulate Robotics.

Today's automotive production systems exemplify a very heterogeneous automation environment in terms of the wide variety of robots, controls, workcells, and equipment that are typically found on the factory floor and production lines. Additionally, the automotive manufacturers must have very flexible and agile production systems that can be quickly and efficiently adapted to meet new model production ramp up. For Reis to deliver timely, cost effective, and accurate production automation systems, they use Tecnomatix tools to design, simulate, validate, and commission complex automotive workcells and production systems.

Moreover, they are able to demonstrate to their customers that these systems will work as designed based on accurate virtual simulation of the physical systems. As the robotic manufacturing cells have evolved into more complex robot gardens that are capable of more complex assembly processes, systems integrators like Reis will have to depend on advanced simulation methods to accomplish the level of automation and synchronization required.

Reis Robotics using advanced simulation technology from Tecnomatix amounts to a win-win situation for all involved in the automation project. Reis is able to design and validate a complex production system with a minimum of engineering resources and time devoted to physical commissioning, while meeting their customer's requirements for automation. Moreover, Reis is able to constantly analyze and optimize the actual production processes during the design and through the implementation stages of the project, ultimately compressing the time it takes for their customers to attain full production capacity.

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Acronym Reference: For a complete list of industry acronyms, refer to our web page at www.arcweb.com/C13/IndustryTerms/

API	Application Program Interface
B2B	Business-to-Business
BPM	Business Process Management
CAD	Computer Aided Design
CAE	Computer Aided Engineering
CAM	Computer Aided Manufacturing
CMM	Collaborative Manufacturing Management
CPG	Consumer Packaged Goods
CPM	Collaborative Production Management
CRM	Customer Relationship Management
DM	Digital Manufacturing
ERP	Enterprise Resource Planning
HMI	Human Machine Interface
IOp	Interoperability
IT	Information Technology
MIS	Management Information System
OpX	Operational Excellence
OEE	Operational Equipment Effectiveness
OLP	Off-Line Programming
OPC	OLE for Process Control
PAC	Programmable Automation Controller
PLC	Programmable Logic Controller
PLM	Product Lifecycle Management
RFID	Radio Frequency Identification
RPM	Real-time Performance Management
SCM	Supply Chain Management

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