

# Using integrated manufacturing to drive the predictive automotive launch

## White Paper

Launching a new vehicle program has never been more challenging. Automakers must satisfy global demand by producing a greater variety of vehicles in an increasing number of regions, and ensure a predictive and successful product launch. Further, they must provide consumer-specified options as well as satisfy a number of geographic preferences and regulations. And they must accomplish all of this across a globally dispersed supply chain. To realize improved launch readiness, faster rampup to volume and first-time quality, automotive manufacturers need to adopt an integrated environment for early planning and development of manufacturing systems so they can achieve more predictable product launch operations and meet program profitability targets.

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# Executive summary

In the automotive industry, there is a growing trend toward an increasing number of product launches on a global scale. Original equipment manufacturers (OEMs) are trying to increase their market share in new regions, and they are looking toward regional production to support this goal. That means that often times the same vehicles are being built in multiple production facilities. But that's just the beginning of the challenges.

Automakers are under pressure to provide a greater variety of personalized options than ever before. They have to reduce costs to compete in global markets, while accommodating an increasing number of process variations to meet the demands from more discriminating consumers. As a result, automotive OEMs face continual pressure to squeeze more time out of schedules that have contracted significantly during the past decade.

To meet these challenges, automotive OEMs need to adopt new manufacturing strategies that allow them to quickly plan and design new processes; accurately assess the impact of changes; rapidly deploy best practices across global

operations and better predict the timing, cost and quality of every program launch. Additionally, they must deliver more environmentally-friendly vehicles and build them with more energy-efficient processes.

To facilitate these strategies, many leading automakers are implementing a collaborative approach that integrates engineering and manufacturing in the development of the launch process. This approach allows for early access to product engineering data so that manufacturing operations work in parallel and processes can be planned, optimized and validated concurrently with design. An integrated approach increases the efficiency of deploying a modular platform that allows for a more predictable launch operation, and provides management with clear visibility into program performance.

This predictive launch approach gives automakers greater confidence that their powertrain, body-in-white (BIW), stamping and final assembly processes will meet delivery expectations, first-time quality goals and program profitability targets.

# The impetus for taking a new approach

Changes in the global automotive market have made launching a modern car program an extremely complex and demanding process. Tomorrow's success depends on an automaker's ability to ensure that their next generation of vehicles is not only energy efficient, but is built with materials that have the lowest possible energy footprint. Further, it must be built to fulfill consumer-specified options as well as a variety of geographic preferences and regulations.

## New materials

Forecasts show that in the next five years, the automotive industry will increase investment in lightweight materials by 80 percent. These materials will require a different set of manufacturing processes that are increasingly optimized for lower energy use in production facilities. Moreover, increasing energy costs and consumer sentiment favoring environmentally-friendly processes will require OEMs to reduce their environmental impact.



## Personalization

Automakers are facing increasing pressure to offer more personalized vehicles while reducing time-to-market. Changing demographics are driving increased demand for higher option and variant content. Whether it is performance characteristics, safety features or entertainment options, these pressures require vehicle manufacturers to standardize their programs on common processes that provide the flexibility to meet this shifting demand and can be efficiently deployed across global locations.

## Globalization

To capture more market share, automakers are increasing configurability of platforms in order to reduce the cost of designing and manufacturing vehicles that meet consumer demand. Program launch schedules have been cut in half over the past decade, and that trend will continue. For automakers, the quantity of buildable combinations will increase the need for more flexible processes that can easily accommodate large variations in configured product. Automotive OEMs need the ability to predict manufacturing operations performance during planning as any change at the start of production can have a dramatic impact on profitability.

# There's a lot at stake

With the increase in vehicle models and the shortening of the product lifecycle, refreshing old product lines and introducing new ones results in multiple implications for automakers. Automakers unable to effectively respond to the aforementioned market trends stand to lose significant advantages in the following areas:

## Quality

Constant pressure on automakers to maintain the quality and reliability of product lines is forcing them to master both individual processes and processes that depend on highly distributed supply chains. Quality control across distributed supply chains and geographies is difficult, and with the increased use of the flexible manufacturing systems, it requires process discipline that conforms to global standards and processes that replicate best practices. Without a high level of process discipline, disconnected operations can lead to variability that can be difficult to detect and increases the risk of quality and warranty concerns.

## Launch success

Launches must occur within increasingly shorter timeframes and at multiple factories around the globe. Achieving launch success depends on each factory's ability to solve the challenges it encounters in real-time. As a result, a global collaboration platform is needed in order to share the experiences and solutions to launch issues amongst the different locations. This can save factories in different locations from solving the identical problem differently, and can significantly reduce the complexity of managing global production and reducing the overhead of facility investments.



## Program profitability

A variety of manufacturing issues can adversely affect profitability. Difficulty in ramping up to required volume impacts the availability of new vehicles to the market, and can result in missing an opportunity to take market share from a competitor. Moreover, unforeseen and unplanned costs can manifest themselves in many activities, resulting in less profitable launches. These costs can be accrued during a variety of common activities, such as new tooling requirements, late changes to tooling, manufacturing and supplier process inefficiencies, and excess overtime due to improperly trained operators, ergonomic issues, inadequate resource scheduling and excessive energy consumption during production. Each of these can contribute to lost units and, ultimately, lost profits.

# Enabling predictive launches in an era of growing complexity

A successful launch is measured not only by the execution excellence of the entire manufacturing process, but also the cost and time it took to develop and build it. To be competitive, automakers must master the transition from mass production to mass customization while fulfilling a variety of local regulations and consistently meeting consumer demand. It is also about being able to absorb the increasing adoption of new materials and new technology to optimize weight and performance and noise, vibration and harshness (NVH) properties. New materials and coating technologies create design changes that can have a significant impact on manufacturability, but can be easily missed without an integrated platform for collaboration. There's no doubt that a product launch is the most costly time to discover and fix product and process deficiencies.

## Execute launches successfully (a predictive approach)

To realize improved launch readiness, faster rampup to volume and first-time quality, automotive manufacturers need to consider opportunities to establish a common and managed environment that is collaboratively linked to product engineering for early exposure to, and development of, manufacturing systems. This enables manufacturing teams to quickly evaluate new, innovative technologies across the manufacturing organization, as well as improve quality, transparency and accuracy in launch execution to better manage product costs and manufacturing investment and minimize launch delays.

## Developing the best way to build vehicles

Capitalizing on new innovative manufacturing technologies within a managed environment supports a successful rampup when launching products in single or multiple facilities. Traditionally, process plans were derived as single-plant operations by looking at the product design of the car in which manufacturing engineers defined the operation sequence and resources needed to assemble the vehicle at a lead plant. This approach was time-consuming and limited in its ability to propagate design changes to every plant where the car was being built. In addition, it was impossible to analyze how changes to one car might impact the production of all other car models that share the same assembly line.

The opportunity now is to take every aspect of the plant that includes a line, station or work cell, and describe the manufacturing operations performed at these places, creating much more granular control of the process plans. With a standards-based approach, automakers can then take the design of a new car and find the best way to build it in the existing layout of the plant. It is also possible to accelerate re-use among the car programs and ensure that vehicles can be built cost-effectively across multiple plants.

This new, more efficient approach enables automotive manufacturers to achieve greater collaborative development of manufacturing systems and more predictive launches.

# Integrated manufacturing solutions support a predictive vehicle launch

Integrated manufacturing can help automakers realize more predictive launches on a global basis. To ensure success, the following key focus areas should be considered part of the overall solution:

## Facilitating earlier access to product engineering data

By operating within the same data management environment as product engineering, manufacturers gain a significant advantage because all critical data (including product, process, resources and plant information) are associatively linked to the most up-to-date information. Just as importantly, capabilities in manufacturing process management enable you to manage data from multiple computer-aided design (CAD) sources, integrate legacy systems and adapt to new technological developments.

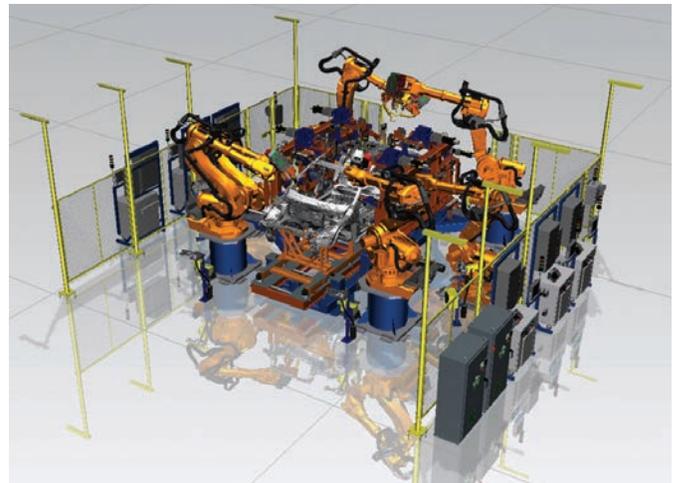
Another key to a successful vehicle program lies in the efficient management of customer configuration options. Program managers need assurance that their assembly capabilities have the flexibility to adapt to option-content scenarios, and final assembly planning has to accommodate a wide variety of supplier-based contributions. These type of flexible applications interconnected through open-data architecture allows effective management of design, manufacturing and production information generated during the automotive product lifecycle, all in a single system.

## Delivering fast and efficient process development

To accelerate the overall time required to achieve full production rates requires a solution that enables rapid design of efficient assembly sequences while accommodating product variants and changes across multiple production facilities. Leveraging a bill-of-process (BOP) definition allows you to capture process logic and flow, and defines the relationships between operations, manufacturing resources and the product. It requires support for early evaluation of manufacturing and assembly times, project budgets and manufacturing costs. Additionally, it must enable line balancing for different order sizes and product mixes, providing early estimation of line throughput, utilization and buffer-size performance.

Another key component to faster rampup is offline programming (OLP) of machine programs. The ability to capture and re-use critical systems programming reduces rampup tryouts and stabilizes operational parameters for long-term profitability. This validation of control programs and machine

operations ensures operational integrity of the complete system, saving crucial time during rampup. Finally, all of the efficiencies built into the systems for one program can then be captured and re-used in subsequent programs, ensuring that your next vehicle launch goes smoothly.



*Comprehensive body in white construction processing and simulation make it possible to try variations of the assembly operations leading to manufacturing plans that are right the first time.*

## Validating manufacturing to optimize process productivity and efficiency

Automotive manufacturing engineering involves a variety of complex and interconnected activities: from part and assembly process planning to plant design, ergonomics analysis and quality planning. Your digital manufacturing solution must be able to be used to support and streamline all of these activities, and align with and improve your entire vehicle development process across all business domains: from powertrain to BIW, paint to final assembly and plant layout to supplier and systems management.

Automakers must take advantage of new innovations and platforms to achieve improved costs, quality and flexibility in manufacturing as they seek to meet the regulatory demands in each market as well as the desire of customers for reliable performance and comfort. Manufacturing must also ensure that the production volumes can be achieved while meeting

quality targets, maintaining operator safety and making sure that the facility meets any regulatory requirements for its geographic location.

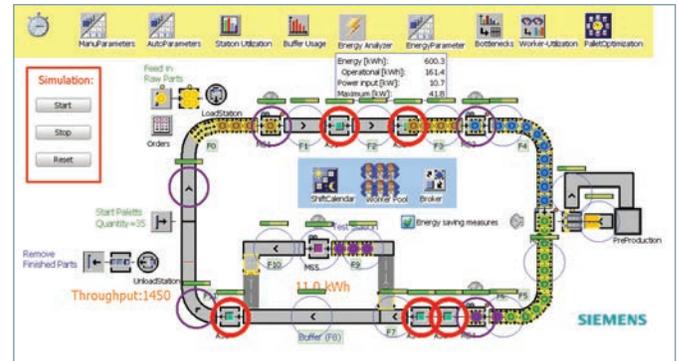
Support for manufacturing feasibility and digital validation analysis can significantly reduce physical installation and rework time. This digital analysis should encompass critical aspects of the assembly sequence, work cell design, complex robotic and human operations, work sequences and execution time optimization.

### Achieving predictable program performance and profitability

Proven production processes, captured as archetypes, can be aligned with product variants and effectivity information to help managers more accurately estimate cost and process capability. This leads to more efficient program execution and profitability. A managed workflow of product and process variants and work-time standards helps process engineers to quickly meet throughput, cycle time and cost requirements. With so much component content added to the vehicle during final assembly, line-side supply is critical. Therefore, you must consider layout and material flow applications (ergonomics and discrete event simulation) to ensure that your final assembly processes are tuned for optimal performance.

Predictable performance also requires validation of build quality. When the links between engineering and production teams are not aligned, production costs rise because quality information is not easily shared and quality management processes are disconnected. An effective integrated manufacturing solution includes dimensional quality applications that bridge the gap between product design and production by increasing the visibility of as-built quality information. This means that manufacturers can consistently deliver on quality targets during launch and rapidly respond when issues occur.

Finally, plant layout influences the performance of all aspects of the vehicle assembly process. From body and paint to powertrain and final assembly, engineers in manufacturing, industrial and plant all have a stake in ensuring that facilities contribute to, rather than impede, optimal process performance. A plant's layout sets the stage for the long-term profitability, process durability and maintainability that is crucial to meeting profitability objectives. Today, a significant variable is your plant's unique energy consumption profile, which can be accurately quantified and optimized for savings by using manufacturing simulation with energy modeling capabilities.



Manufacturing simulation makes it possible to optimize a plant's layout and material flow, as well as predict and optimize energy consumption.

# Siemens PLM Software provides the catalyst for change

Siemens PLM Software provides an integrated manufacturing solution that helps automakers execute global automotive programs with maximum efficiency. Our solutions have helped leading OEMs to achieve their first-time quality goals. They were able to quickly ramp up their production volume by making sure that their assembly lines met quality targets and were balanced and optimized. Our product lifecycle management (PLM) tools also support modular platform strategies that are adopted by OEMs to reduce cost overruns related to manufacturing and an increasing number of vehicle options.

This is accomplished in the most productive fashion through the collaborative development of manufacturing systems for powertrain, BIW and final assembly processes on a global scale.

## Powertrain manufacturing

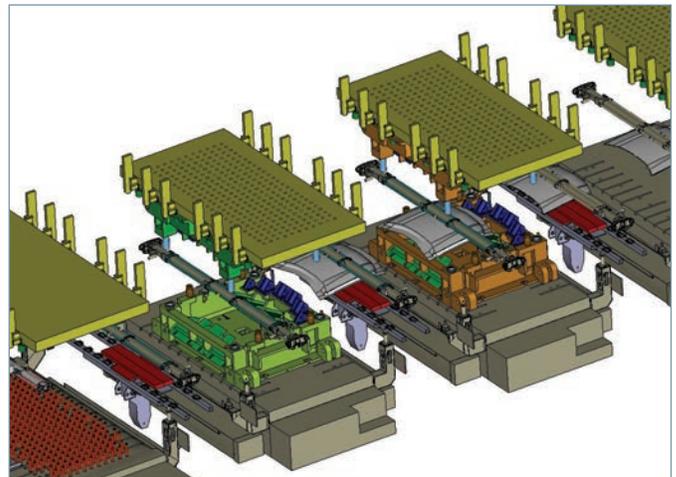
Every second counts when performing high-volume production of complicated components in succession on dedicated machines. In order to take full advantage of your investment in powertrain machining resources, and reduce investments by minimizing the number of necessary machines, a highly optimized sequence of manufacturing operations is needed.

Our integrated manufacturing solution supports the sophisticated machining requirements of engine blocks, transmissions and drive components. Close adherence to quality and tolerance targets are critical at this stage. Our solution is used to analyze part geometry for manufacturing features as well as manufacturing requirements, such as tolerances, surface finish and threads, and automatically matches them to corresponding machining methods and resources, such as cutting tools. Full 3D machine kinematic simulation of the computer numerical control (NC) program can be performed to optimize cycle times and ensure safe, collision-free tool paths. An integrated set of postprocessors and closed-loop feedback between the shop floor and the NC programmers enable accurate execution of NC programs.

## Stamping die and press line solutions

Automotive stamping dies and press lines are high-cost, long lead-time investments. To maximize return-on-investment (ROI), it's important to streamline development and commissioning of new lines, while flexibly adapting existing lines to new designs. You can plan, design, validate, manufacture

and commission your press line equipment by leveraging our integrated manufacturing solution and Siemens PLM Software production equipment (which includes controllers and drives). Siemens PLM Software solutions are used by leading companies to optimize operational efficiency and reduce time, cost and errors in design, planning and production of sheet metal parts and dies.



*Comprehensive die validation and press line simulation makes it possible to verify and optimize key elements of the press line job early in the planning phase.*

## BIW assembly

A mixed-model BIW assembly process requires flexible manufacturing capabilities. To significantly reduce equipment installation and commissioning time, Siemens PLM Software solutions are used to analyze and validate robotic operations and line performance digitally. Our integrated manufacturing solution enables detailed design, simulation and optimization of collision-free robotic and manual operations for spot-welding with automatic robot placement and gun selection. Additionally, for line-performance optimization, you can use our discrete event simulation, which analyzes throughput, resource utilization and bottleneck detection and buffer sizes.

### Final assembly

Late-stage changes significantly impact program profitability and scheduling. Siemens PLM Software's integrated manufacturing solutions mitigate the risk of late changes by providing an integrated virtual environment for simulating and validating production plans before physical implementation.

As the number of options and variants expands for a particular vehicle, it becomes increasingly important for the final assembly operations team to be able to effectively manage any changes to the manufacturing bill-of-materials (MBOM). As a result, the Siemens PLM Software solution not only supports the ability to develop separate MBOMs for specific plants or regions, but also to link the MBOM to a single engineering bill-of-materials (EBOM). Other systems often require replication of the EBOM at every plant. By comparison, this linkage in the Siemens PLM Software solution enables manufacturing operations to keep up with a high frequency of engineering changes.

Moreover, the Siemens PLM Software solution can be used to manage plant-specific processes through a global bill of process, streamlining the ability to accommodate and manage constant change as well as synchronize proven processes throughout the enterprise. If desired, improvements and changes made at a particular plant can be fed back to central planning and then pushed to all other plants. Refinements during launch in the first plant can then be leveraged in subsequent launches in additional plants, making faster rampup-to-volume time in regional markets.

Finally, our integrated manufacturing solution enables the detailed design, simulation, optimization and documentation of the vehicle assembly process based on the defined BOP. A specific line's performance can be optimized and balanced with statistical simulation that is integrated with ergonomic analysis to ensure optimal performance without posing a risk to a worker's health.



*Advanced assembly planning makes it possible to bridge the connection between the product bill of process (parts/operations) and the plant bill of process (resources/equipment).*

# Conclusion

Automotive OEMs must operate effectively and efficiently in this manufacturing and production environment while managing the increase in product complexity across the globe. Automakers need to achieve first-time quality requirements, reduce the time to rampup and eliminate cost overruns in order to compete successfully in the marketplace. Rapidly designing, re-using and validating manufacturing processes before implementation has proven critical to the success of automotive OEMs.

Siemens PLM Software solutions for automotive vehicle manufacturing, including powertrain, BIW and final assembly, are focused on helping OEMs succeed in today's globally dispersed business environment by supporting predictive product launches.

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## About Siemens PLM Software

Siemens PLM Software, a business unit of the Siemens Industry Automation Division, is a world-leading provider of product lifecycle management (PLM) software, systems and services with nine million licensed seats and 77,000 customers worldwide. Headquartered in Plano, Texas, Siemens PLM Software helps thousands of companies make great products by optimizing their lifecycle processes, from planning and development through manufacturing and support. Our HD-PLM vision is to give everyone involved in making a product the information they need, when they need it, to make the smartest decision. For more information on Siemens PLM Software products and services, visit [www.siemens.com/plm](http://www.siemens.com/plm).

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