UL Solutions

SOFTWARE INTENSIVE SYSTEMS | WHITE PAPER

Orchestrating automotive product development and operations

LET'S GO

Within UL Solutions, we provide a broad portfolio of offerings to many industries. This includes certification, testing, inspection, assessment, verification and consulting services. In order to protect and prevent any conflict of interest, perception of conflict of interest and protection of both our brand and our customers' brands, UL Solutions has processes in place to identify and manage any potential conflicts of interest and maintain the impartiality of our conformity assessment services.

Technological progress is accompanied by change. Organizations must adapt both product development and operational workflows. Having process models at the level of detail to allow improvement through continuous learning is paramount. Process models help reveal workflows across teams, people, platforms and programs.

Product complexity will continue to increase. Digitalization will grow to augment product development and service. Engineers will continue to work in distributed teams, sometimes away from the office. Industry standards will focus heavily on reducing risks to protect customers. All these aspects must be addressed and reflected in the workflow used to develop products. This paper describes how to overcome highly complex engineering practices and methods by transforming to an agile, flexible and model-based Product Development Process (PDP).

Automotive products have changed significantly in the last 10 years. Many automakers use a form of staged gate reviews that are largely driven by manufacturing capital investment and supply chain optimization. Internet of Things (IoT), machine learning and work automation are all contributing to life cycle changes in products, even during their operating life. Autonomous technologies are now available, starting with freight and providing driverless transportation building blocks for the future. Sensing and reacting to obstacles has been the responsibility of the human operator. As machines replace the driver, product complexity is exploding. On top of this is the shift from internal combustion engines and transmissions to electric drive propulsion. Fitting new technologies into the product platforms, without impacting quality, requires agile process management.

Silos abound, can technologies help?

In automotive product development, system optimization happens all the time – with effects to chassis, brakes, wheels, powertrains and others. Such optimizations are usually done across system domains by parallel groups of experts. Concurrently, additional cross-domain computing power and embedded software is being put into the vehicle. Thousands of engineers working in parallel, grouped in various teams around the world, are required to remain competitive.

The order of decisions is often the critical path, and this path is under constant competitive pressure to shorten, without adversely impacting quality. It is hard to identify the work products in this silo picture, other than what the manufacturing plant produces. Enterprise orchestration needs a framework, like the musical score in a symphony. A living process model is that framework. This is how the different silos know how to play their part and together deliver a high-quality product. The product is the performance of the musical score. Stages provides the framework to support product development and helps orchestrate the performance that produces a product.

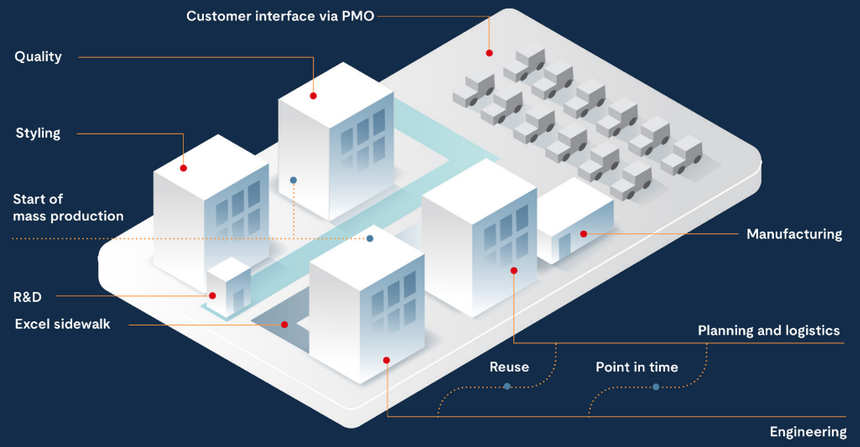
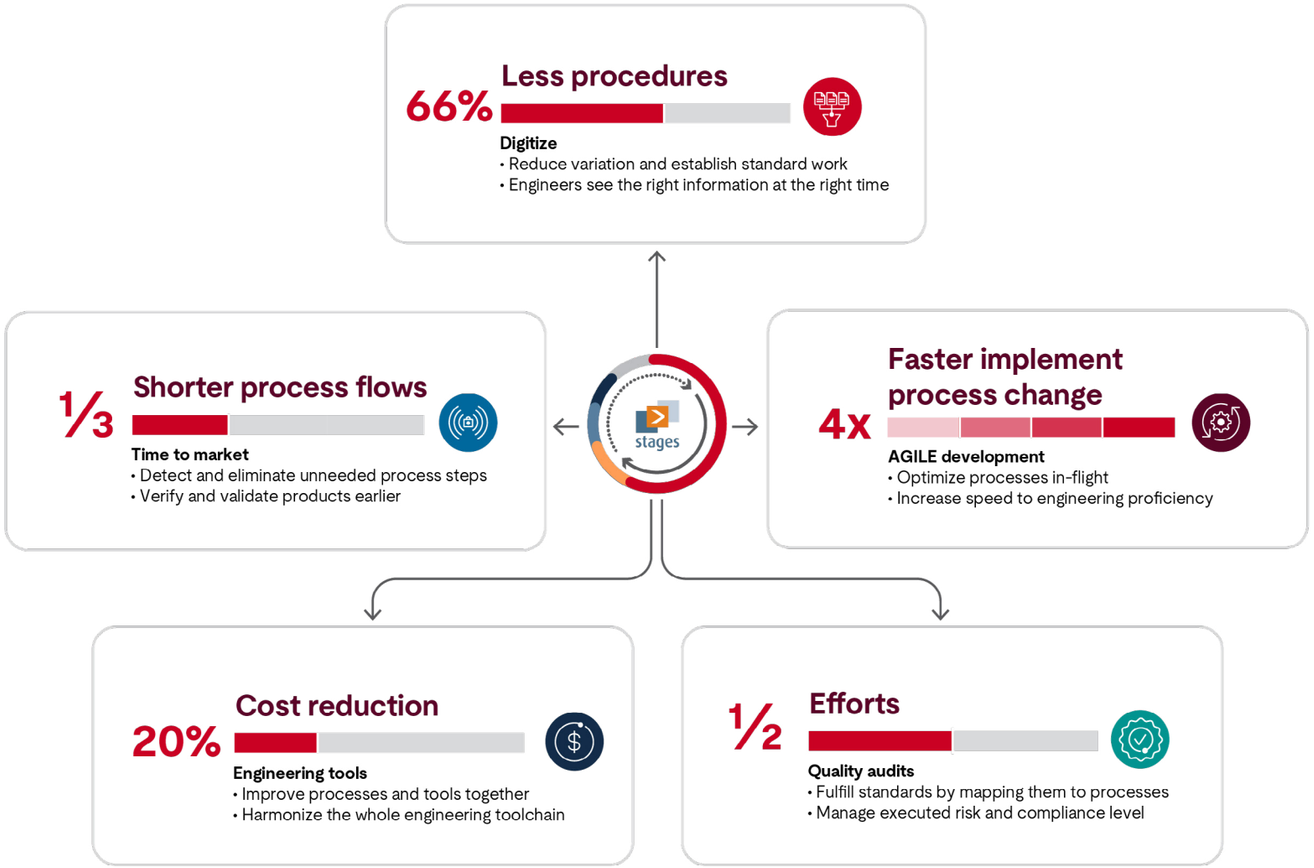


Figure 1: Technology silos of experts, connecting organizations at decision points.

Figure

2

Proven achievements at companies that transformed to a model-based PDP.



Reasons to transform with a model-based PDP

The core idea of model-based processes is to move all design and quality artifacts, even business artifacts, into an interactive process model. In the past year, UL Solutions has developed a working model to demonstrate how a company might go about modeling their enterprise processes. The model accounts for the creation of stable architecture that integrates all the necessary process areas. This approach also eliminates duplicates, inconsistencies, unnecessary variants and obsolete information while underscoring the importance of malleable, capable and accepting new technologies. Figure 2 shows five proven reasons to transform to a model-based PDP just to stay competitive.

How to start modeling a PDP

Often process architecture is based on skills and current competitive advantages. However, it is crucial to focus on the most important value streams within product development as well. After defining the deliverables that capture the value, one can model the detailed processes to create those deliverables. Other work needed to support the deliverable may or may not be modeled in the process — it depends on whether the context transparency would help others in the organization.

In regulated environments, like functional safety, cybersecurity and mandated reliability, avoiding defining disconnected processes on top of already existing product development processes and practices is imperative. By defining a unified product development process and mapping elements of relevant standards and regulations onto those process assets, it is possible to effectively find compliance gaps and generate evidence for audits and assessments. Efforts for preparing and conducting compliance audits have decreased by up to 50% (Figure 2) when using Stages.

Over time, fast and expanding organizations accumulate a variety of different methods and tools that create variance in outputs, are difficult to integrate and incur high costs for tool licenses and maintenance. By adopting a “tools follow process” approach, organizations can standardize their work, greatly reducing the number of applied methods and tools by up to 80% (Figure 2). This also helps focus innovation activities based on the company’s market conditions and product leadership initiatives.

Knowing which process needs to adapt, and in turn which tools and methods are worth investing in, helps improve financial throughput of the company as it pivots. High process acceptance is critical for the success of every PDP transformation. Theoretical processes are often ignored and lead to frustration among the engineers. To avoid these aggravations, many quality manufacturing circles involve users in their process change initiatives. Then, monitoring process usage and behavior uncovers additional insights, resulting in further process improvements managed and implemented by operators of the process. Agility practices allow capturing, implementing and deploying process changes up to four times faster (Figure 2) as an effective way to achieve and measure continuous learning — a hallmark of successful companies.

Figure

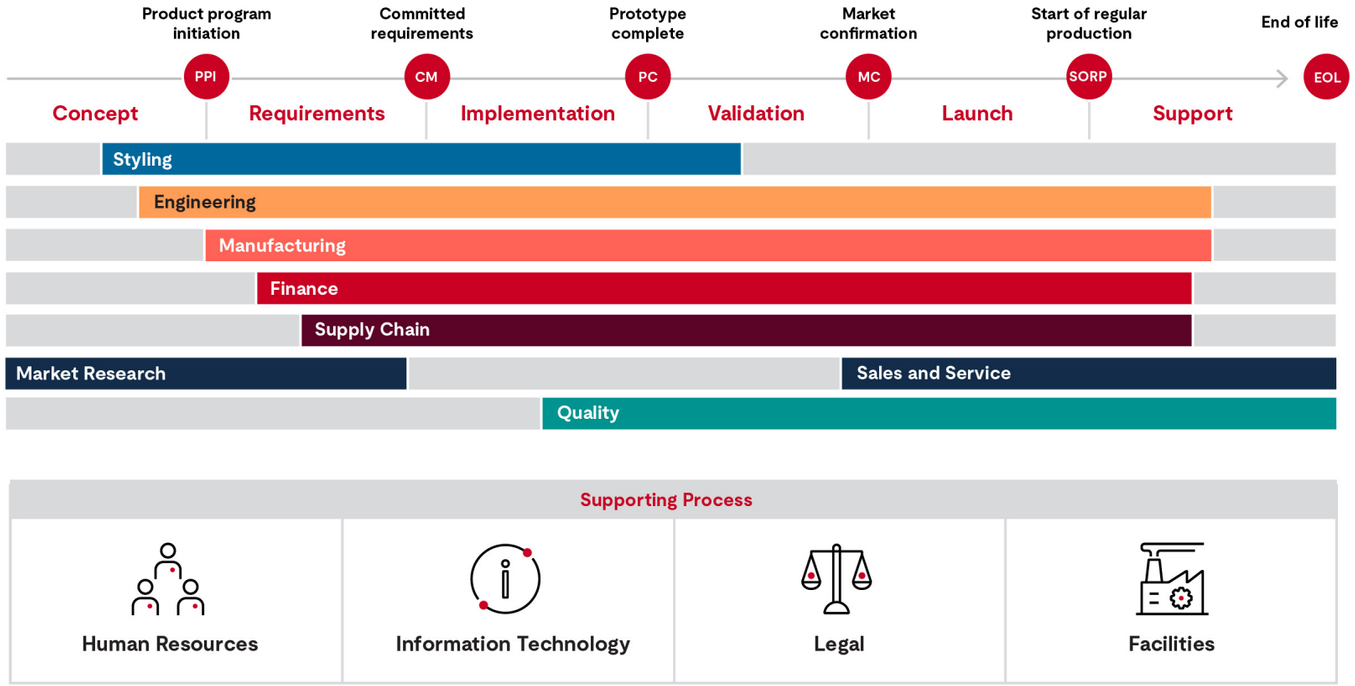
3

The PDP brings a product to the marketplace from planning to production.

A PDP framework that helps

Product decision cadence and procedures need orchestration that is workflow driven by proven processes. The process manager's task is nothing less than turning the system from a "tool for aid and education" toward an interactive focal point of applied knowledge and best practices, even in distributed product development. Based on industry best practices gained in almost two decades, Stages offers a new holistic solution for a model-based PDP. It covers the entire enterprise; not just engineering, but also program management, styling, manufacturing and the rest as shown in Figure 3.

Product Development Process (PDP)



Stages provides modeling of a complex system of systems processes. Users benefit from a practical guideline that shows them how to orchestrate all the interactions between working groups: What needs to be done? How is it done? Why is it done? When is it needed? And who is responsible? The process is documented by each functional area to standardize tasks and link to detailed work instructions, guidelines and templates. Engineers can use the process to understand the tasks they need to perform — and task instructions contain learning and best practices. Furthermore, engineers can understand the context in which their work products are used by others in making decisions. This way, the people executing the process feel empowered to improve the process, which leads to a culture of continuous improvement and a learning organization.

Processes from different viewpoints

Each swimlane of a foundational product development landscape has its own proven processes. It brings a release to a coordinated gate review, where progress is evaluated. Some disciplines will provide proven subsystems. Other disciplines will develop new subsystems driven by changing customer requirements. Product performance, which needs coordinated changes across the enterprise, will be assessed at each gate. The next round of refinement proceeds once the current gate criteria have been met. Orchestrating all of this is a development framework, the PDP model, with key teams and their specific roles producing their parts.

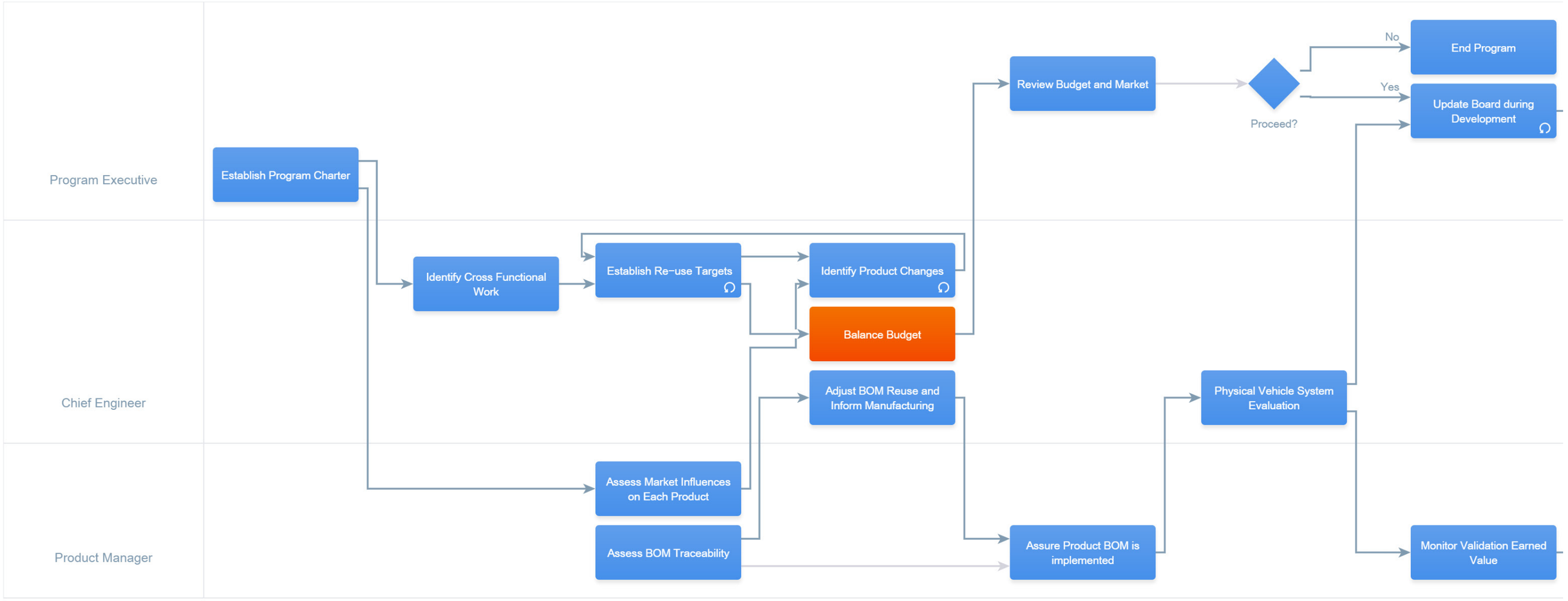
The Program Management Office (PMO) contains three key roles: Program executive, chief engineer and product manager (Figure 4).

A lean view, or value earned view, shows key work products and their status at the gate (Figure 5). A succinct view of value provides the PMO leadership an indication of progress to standard, proven measures.

But where did these work products come from and what were the temporal and organizational contexts? A third view from the same PDP model reveals the swimlane connections (Figure 6). Gray boxes illustrate the inputting and providing of artifacts with other disciplines.

To keep product development on the right track, it is possible to examine each discipline and its work products, or artifacts, with status in a value view. Figure 7 is the PDP example for the work process creating the mechanical structure of the battery pack. The status indicators for work products have been placed into a data repository. Management could focus on red, then yellow, work products to better manage risks. Each discipline (PMO, engineering, supply chain, quality management and manufacturing) has processes producing value. If those are modeled and integrated at key gates, it provides insights on bottlenecks, missed value and general progress. This is the power of using a model for a complete product development process.

Figure 4: Activities view of different roles within Stages.



Figure

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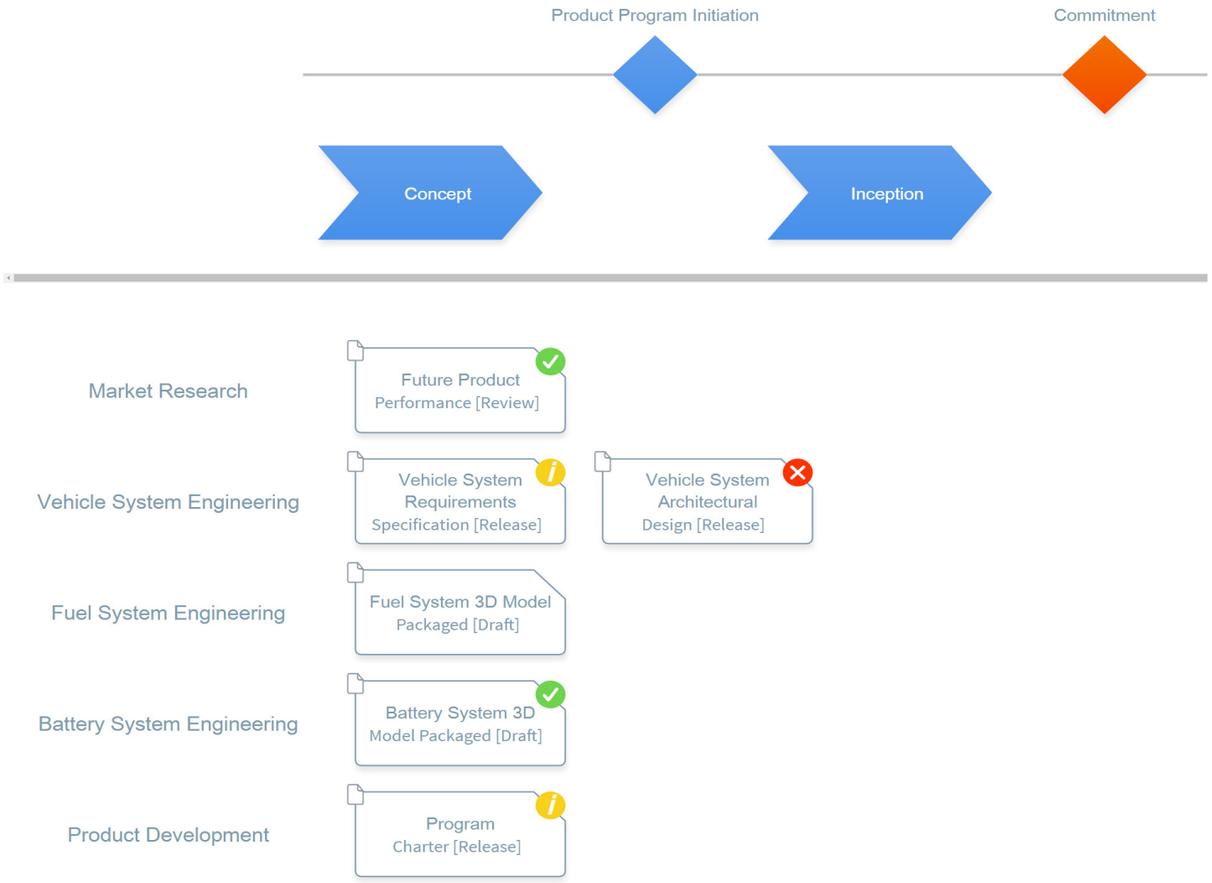
Sample view of key work products at the second major milestone — commitment.



Figure

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Swimlane connections view on the process.

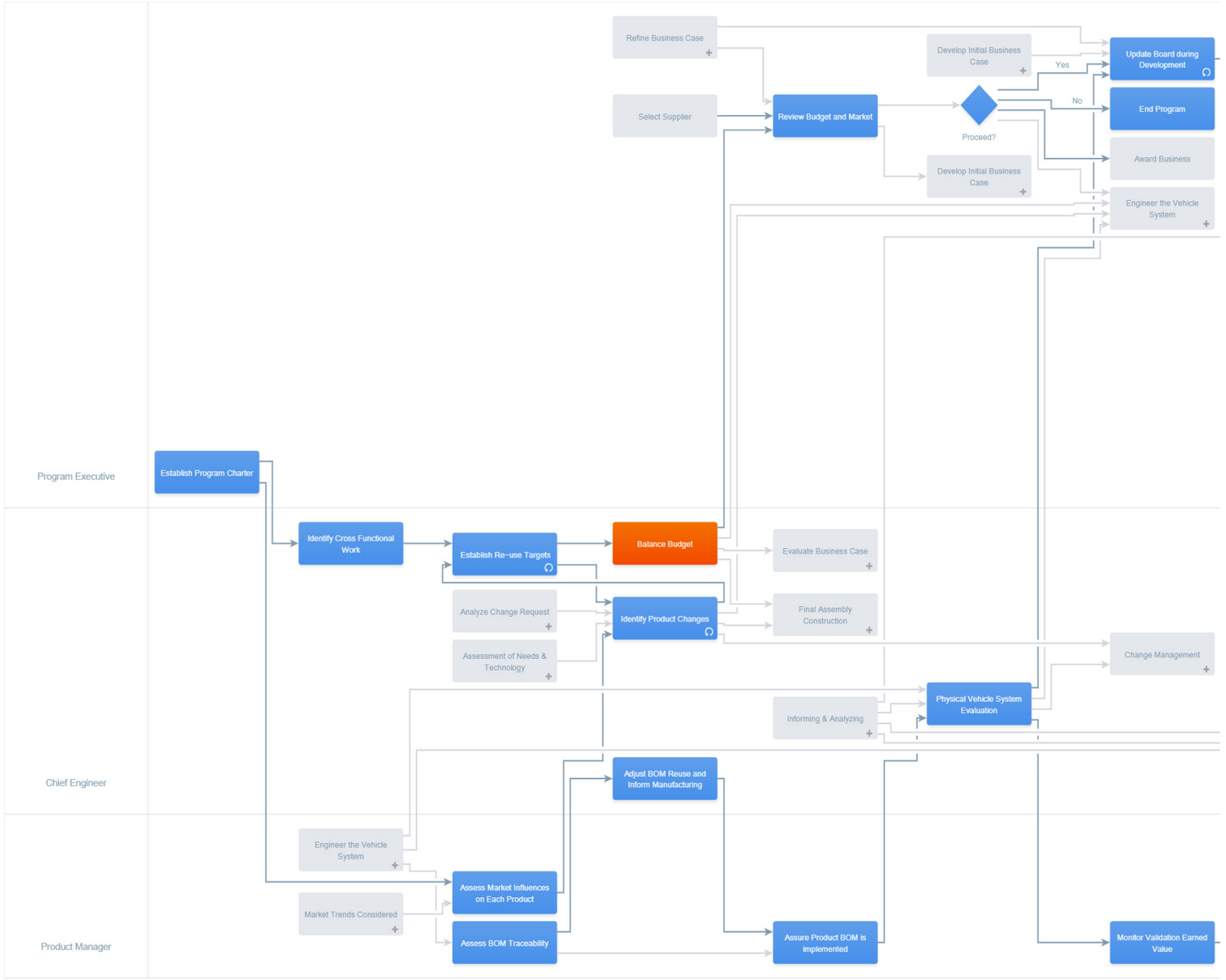


Figure 7: View on final status of a process.

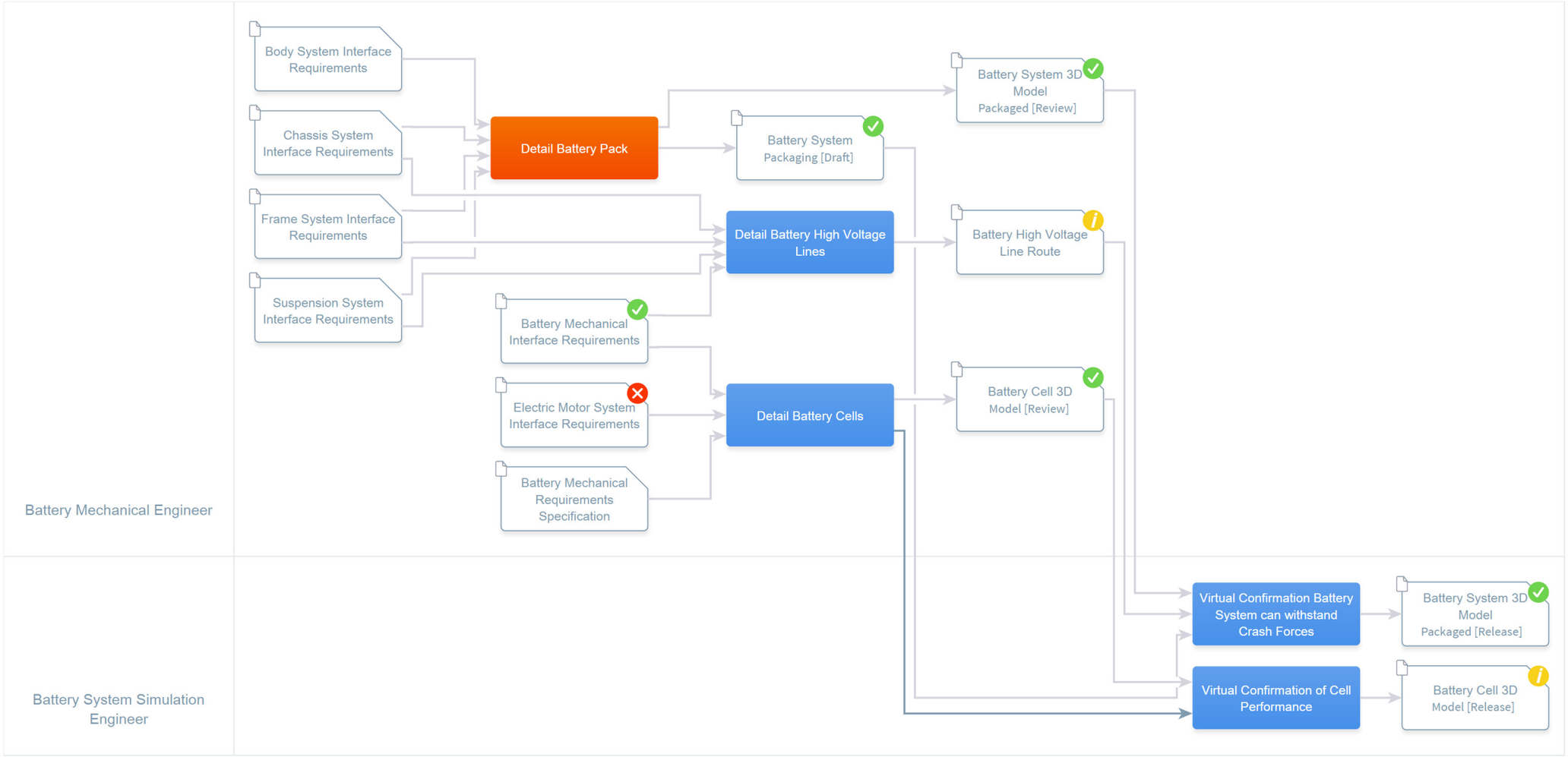
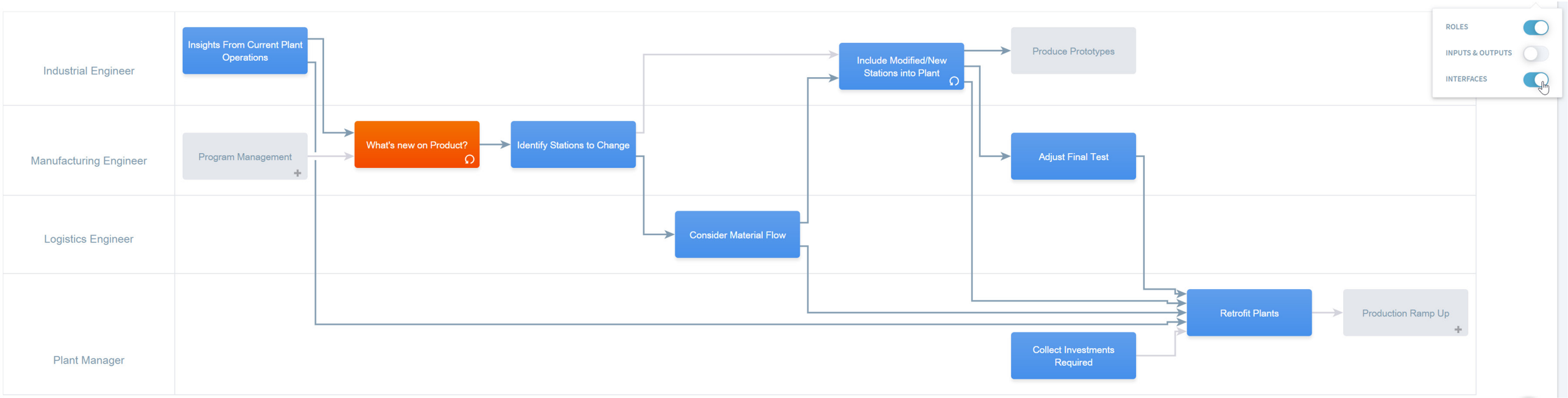


Figure 8: PDP model of final assembly at a fictitious automaker in Stages 7.6.



Get the next organization started with process modeling
A good way to start modeling processes, such as manufacturing engineering, is to look at the major roles and the interfaces to product engineering, plant management and the PMO (Figure 8). By focusing on a specific activity, manufacturing engineers can start working on changes needed in the assembly plant. They are also aware of the way the manufacturing plant has been operating. Note the gray boxes in Figure 8 as interfaces outside of the manufacturing processes, both modeled in Stages.

Summary and takeaways
The PDP model helps explain the dependences of all systems and people within the enterprise. It serves as a base to start modeling a department's work (their silo) in detail, and to engage department members in process improvements. As benefits become obvious, it encourages other departments to model the details of their processes, quickly identifying opportunities for the efficiency benefits (summarized in Figure 2).

UL Solutions is offering a generic PDP that provides examples for engineering, quality, supply chain, finance, styling, market research, manufacturing and service. It can even be used to track the accomplishment of value once integrated with the artifacts located somewhere in the PLM/ALM ecosystems.

6 key lessons of applying the PDP model in practice include:

- Operators improve processes willingly when involved from the beginning
- Process ownership by expert practitioners will help adoption by the users
- Process improvements occur best with defined objectives, goals and metrics
- Start enterprise process modeling by looking to value streams — they produce the critical artifacts
- Different views of the process improves decision-making
- All views should come from a common database of activities, work products, best practices and their interdependencies

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