ARC PROFILE

By Greg Gorbach

True Product Lifecycle Management Begins When Design Ends

Consider that the end-to-end lifecycle of a product begins with the first spark of innovation and ends when the product is dismantled, recycled, consumed, or disposed of. Managing the "product lifecycle" demands more than managing the product's design, introduction to manufacturing, and associated documentation. It also requires managing all the processes involved during various production operations, as well as managing the warranty, service, maintenance, and repair processes and in some cases the recycling/disposal processes. A manufacturer's business model and strategy may dictate involvement in all or just a few of the lifecycle stages - but obviously most manufacturers are involved in areas in and around the actual production and need to manage these critical phases of the product lifecycle.

> During the *Production* and *Aftermarket Support* phases of a product's lifecycle, systems for managing Process Engineering and Planning, Process Execution, Process Quality, and Maintenance, Repair, and Overhaul ensure that product designs are properly implemented according to design specifications and procedures, and that all required production information is captured in the process.

Product Lifecycle Phases

Product Lifecycle Management (PLM) is conventionally viewed as being focused on product design, but a significant portion of the product's lifecycle occurs downstream from the design process. How do leading manufacturers manage this product lifecycle today? What roles do information systems play during the various stages of production and when a customer submits a product for repair or overhaul?

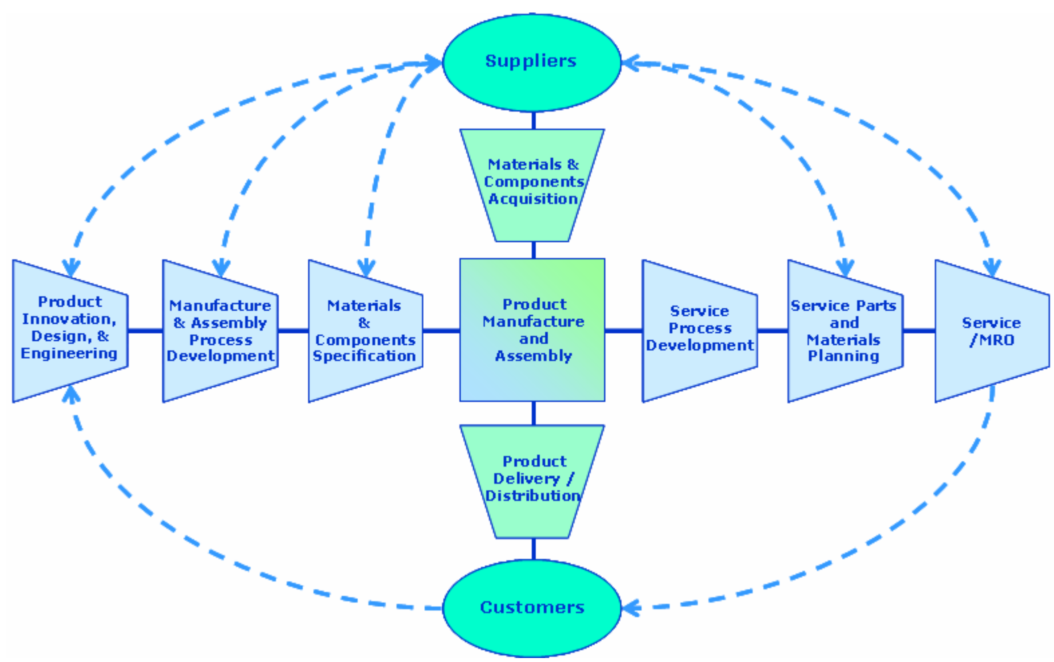
Product Innovation, Design, and Engineering

The lifecycle of a product begins with a customer need or in Marketing with a concept. It is turned by Product Engineering into a product design, which is captured into 3D models using CAD software tools. The product structure information and product specifications can be found in the CAD models and in Product Data Management (PDM) tools. These PDM tools have added features to facilitate online change and approval processes for CAD models, where several groups can collaborate online on a product design. The industry has come to use the term "Product Lifecycle

Management" (PLM) to describe their functionality, but this class of applications only addresses the Engineering side of a product lifecycle. What about the build history of each unit? What about the service history of each unit?

Materials and Components Acquisition: Supplier Management

Though selected suppliers will have collaborated in the design and engineering phase, specifications and inspection requirements must be communicated to all the suppliers that will build component parts for these products. Pricing, contracts, and schedule for the delivery of the component parts must be negotiated, and the receipt and inspection of those parts must be managed. These functions are typically handled by a combination of PLM, ERP, SCM and Supplier QA systems, often together with Lean or Kanban functionality in shop floor systems.



"Product Lifecycle" Extends Well Beyond Design and Engineering

Managing quality in the supply chain is a top concern for manufacturers who outsource a significant percentage of the manufacture of their product. They must protect the high quality reputation associated with their brand names. Manufacturers need a supplier quality management system that can help manage the provision of specifications and quality requirements to the supplier and can dynamically increase or relax oversight of suppliers for each order and shipment according to their recent quality performance.

Manufacturing / Assembly Process Development

As the product design begins to firm up, the design and development of the manufacturing and assembly processes begins. Depending on the operations involved, this may include design, simulation, and validation of assembly lines and robotics, machine tools and workstations and the like. Where technicians are involved, work instructions are created. These work instructions spell out the required equipment and tools, and also specify how the product will be inspected. Required tooling fixtures must be developed. To verify the products are made to Engineering specifications, critical measurements must be identified and properly called out in the work instructions, with buyoff signatures where necessary. Sampling rules must also be included in the work instruction set – check every part, or every tenth part? In this phase, manufacturing simulation software can be used to validate tool designs and to validate the manufacturing and assembly processes before tools are made or shop floor layouts are changed. Digital Manufacturing is beginning to play a big role here, and in some cases virtual products are being validated against virtual production lines.

Manufacturing Execution and Quality Planning systems are used to develop work instructions and inspection plans. Legacy planning systems tend to produce paper for the shop floor, but more and more manufacturing shop floors are becoming paperless. Better new planning systems support a paperless online execution environment consistent with today's best practice.

Product Manufacture and Assembly

In this phase of the Product Lifecycle, orchestration, control, and documentation of the manufacturing process are paramount. Quality raw materials and components must be made available at the right place and time. Properly trained and certified operators must be scheduled for the work. Equipment, consumables, and tooling must be scheduled and available where needed. Current, complete documentation must be at-hand, and controlled change procedures must be in place. Routings, assembly instructions, inspection and test operations, and buyoff signature requirements must be executed. Every action that is taken, every measurement made, every piece of equipment used, every operator involved, and every document used is a part of a product's life record, and it must be gathered, stored, and analyzed. Ideally, a portion of the information feeds back to design engineering and process engineering for ongoing improvement, and some information feeds forward to downstream service and support functions. In operation, modern best practice is to ensure that certain real-time information is visible to enterprise systems and people in a variety of business roles.

The product is built and inspected to ensure that Engineering specifications have been met. When a discrepancy is found, it must be documented and dispositioned. The decision must be made to repair the product or scrap it, and the results of either action become an important part of the product's lifecycle. What has been done to each product to get it back to Engineering specifications? Manufacturing Execution Systems (MES) and Quality systems are used to capture the data for each product manufactured, and information about defects and their disposition.

Aftermarket Product Service

Does the product lifecycle end when we deliver the product? For many products it does not. Many products, like cars and airplanes, are designed to be maintained for many years. The more complex and expensive a product is, the more likely it will have an extensive aftermarket service life. These products are designed to be periodically inspected, serviced and overhauled.

Service Process Development

Work instructions for product service and maintenance are often developed independently and in parallel to work instructions for manufacturing. At what points, and how often should the product be inspected? Where should technicians look for wear and tear? What critical measurements must be recorded? Maintenance, Repair and Overhaul (MRO) Planning software can be used to plan the service tasks and make sure that all OEM Engineering instructions, directives and bulletins from regulatory agencies are complied with.

Service Provision

MRO Execution software is used to record inspection findings and document the entire maintenance history on each product unit that comes in for service, repair or overhaul. This includes cleaning, lubrication, tuning, parts removed, parts installed, modifications and upgrades. During the maintenance process, opportunities for product design improvements are often discovered, and must be communicated back to Product Engineering. Engineering changes must then flow to both production lines and to service operations.

The service history of each product unit is recorded and maintained until it reaches the end of its lifecycle, retirement. During its life, a particular product unit contributes to the lifecycle of the entire product family with its history, issues, and resolution experiences – all of which lead to improvements that become part of the next generation of the product line.

Conclusion

In today's software landscape, a "PLM" system houses part of the information for the product lifecycle, but the rest of the information is found in business systems such as ERP and Supplier Management, and in plant systems such as Manufacturing Process Engineering and Planning, Process Execution, Process Quality, and Maintenance, Repair, and Overhaul systems.

Manufacturing Process Engineering and Planning systems enable the efficient production of the product. They provide illustrated interactive work instructions, task information for operators, complex operation precedence flow, authoring, review and approval workflow, process change and release control, and change release and deployment

Supplier Quality Management systems ensure that suppliers meet the expected quality standards to Engineering specifications. Supplier quality management systems can dynamically increase or relax oversight of suppliers in real-time according to their performance. These systems do not just change the suppliers' ratings, they change the inspection and audit requirements for each order dynamically over the web, based on the recent history for each product line and related manufacturing processes.

Manufacturing Process Execution Systems ensure that the designed manufacturing process operates effectively, coordinate the flow of inventory through the manufacturing process, provide work instructions to operators, provide traceability, and provide real-time sharing of information throughout the enterprise. In addition to the primary role as the process driver for the production phase of the product lifecycle, these systems also play an important role in coordinating the introduction of engineering changes into the active production stream, as well as collecting and feeding back pertinent product and process data to the design/manufacturing engineering team.

Manufacturing Process Quality Systems manage discrepancies and nonconforming product documentation and dispositioning; provide rework, repair, scrap, or return to vendor dispositions; provide configurable authoring and approval processes for rework and repair instructions; drive corrective and preventive actions (CAPA), and provide Lean Six-Sigma performance and quality metrics.

Maintenance, Repair, and Overhaul (MRO) systems ensure that the planned maintenance schedules, visits, and tasks comply with all maintenance requirements, coordinate the flow of inventory through the process, provide work instructions to operators, provide traceability, and provide real-time sharing of information throughout the enterprise. MRO systems also allow for the management of non-routine maintenance tasks that are added to the work scope based on the findings during inspection of the product.

iBASEt's Solumina product suite delivers information about the entire product lifecycle by marrying the Product Engineering data with the actual manufacturing, inspection and service data starting at the Suppliers, through Manufacturing and through the service of the product in MRO shops. This product history can be mined by Product Engineers to verify that the product is performing as designed and to look for areas that have been causing the most difficulties during production or maintenance of the product.

"Many companies are starting to see the value of having the entire product history record in one database for regulatory compliance and data mining for continuous improvement processes, but we still see a big opportunity to turn this information into additional value for the product customers" Conrad Leiva, VP Product Marketing at iBASEt. "We would like to see the history of component parts traveling through the supply chain and incorporated into the final assembled product. We would also like to see a product's history traveling with the unit from one MRO shop to the next. These goals can be accomplished with the technologies available today."

ABOUT THE AUTHOR:

As ARC's Vice President for Collaborative Manufacturing and Architecture, **Greg Gorbach** is a thought leader in Collaborative Manufacturing and provides clients in a number of manufacturing vertical markets with strategic advice in dealing with boundary-crossing business processes. Greg's primary areas of focus are Collaborative Manufacturing, Production Management, Business Process Management, Manufacturing Performance Services, and the synchronization of plant systems with CRM, ERP, PLM, Supply Chain and other business systems. He brings over twenty years of hands-on experience to ARC, with direct experience within manufacturing organizations, as well as extensive experience with suppliers to manufacturers.

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