Why 'Connectedness' is Critical to New Product Development

Companies make significant investments when they approve a product idea for development. Employee, capital, and facility resources are devoted to transforming the idea into reality. There is also a lot of information associated with that product program to manage.

Along the journey to start of production, program teams are routinely asked some simple questions by the program sponsors: How much will it cost to produce? What does it weigh? Is it better than our competitor's? Will it be profitable?

How efficiently a program team can answer these questions will determine the project duration, the product's market success, and to some extent, its quality.

To manage the information to help answer these questions, companies invest in systems like CAD, PDM, PLM, and ERP.

Typically, if an organization has implemented PDM, the value of organized design data is understood. The evolution of PDM to PLM allows for management of the design data, plus much of the cross-functional information surrounding the design content throughout its lifecycle. These concepts are not new.

In addition to managing information to deliver the product to market, an organization also needs to innovate for its long-term viability. To innovate, people need to communicate, which enables collaboration that sparks the innovation.

The gap is in how to connect the people, processes, and systems to most effectively enable innovation through business intelligence.

This article discusses how Mercury Marine's PLM team has worked with the cross-functional business to help create a connected community that enables innovation through a variety of strategic touch points.

The first portion of the article will focus on establishing a standard product definition within the PDM environment. This helps provide a consistent design structure to PLM and enables its role in providing the connected community within as users start communicating and collaborating. Much of this work has culminated in several successful solutions and process-methodologies that will be described within this article.

As often happens, a galvanizing event occurred within the business to help provide the catalyst for the change necessary to push these connected solutions from prototype to global user acceptance.

In this case, a clean-sheet engine design was required to remain competitive in certain horsepower ranges. Recognizing that a potential downturn was on the horizon, Mercury's management agreed this development program must result in a modern, cost-competitive engine available for sale in near future.

"During the engine's development lifecycle, the company was forced to reduce its workforce due to the downturn, placing even more pressure on the organization to get the program ready for market," noted John Bayless, director of program management for Mercury Marine. "To help manage these challenges, the organization turned to the PLM team to provide a path forward."

As the PLM strategy evolved, it became critical that Mercury's CAD processes maximize data reuse opportunities downstream. For example, a Large Assembly Management (LAM) methodology allows designers to create standard product structure for new development programs. These structures establish an engineering bill of material structure based on design functional partitions, which is also how the engineering team is organized. By aligning the personnel with a consistent bill of material structure, the team achieves

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the following benefits:

- Designers can open large assembly structures within ProE and Teamcenter
- Downstream users outside of engineering can perform at a higher level because they know where to consistently find parts based on the product structure
- Team members can efficiently consume accurate, 3D virtual versions of products using JT lightweight viewable files. These virtual product representations are used by tech publications, manufacturing, procurement, and program managers to more efficiently and effectively communicate information about a program or perform work faster and more accurately.

"The new product program teams have benefited tremendously from these PLM practices," emphasized Bayless. "One of the most beneficial aspects of this PLM strategy has been the early involvement of cross-functional contributors in new product programs."

For a new program, the design team starts with a product structure based on the large assembly management template mentioned earlier. Then the designers start populating the

OUTBOARD TOP LEVEL ASSEMBLY STRUCTURE

LEVEL 1	LEVEL 2	LEVEL 3
Product Identifier: Project Name and/or Model	Primary Structure	Secondary Breakdown (Groupings)
END MODEL		
	Base Engine	
		Short Block Structure
		Cylinder Head System
		Cranktrain
		Valvetrain Drive
		Lubrication Delivery
	Peripherals	
		Fuel System
		Intake System
		Peripheral Mounting & Drive
		Fluid Containment & Routing
	Electrical System Assembly	
		Ignition System
		Charging System
		Starting System
		Sensors & Switch
		Control System
		Wire Harness
	Mid Section	
		Driveshaft Housing System
		Adaptor Plate Assenbly
		Oil Sump Assembly
		Exhaust Tube Assembly
		Muffler Assembly
	Transom	
		Mount system, trim system, Steering Mechanisms
	Drive Train	
		Gearcase System
		Shift Mechanism
		Propeller
	Cowling and Integration	
		Cowling
		Graphics and Decals

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structure with part numbers for proposed new parts, as well as adding all the existing parts they believe are required at that time.

This is where PLM helps enable cross-functional collaboration. The standard large assembly management methodology based on the functional partitioning provides a consistent product structure across all development programs to drive standardization.

"Having a common BOM management technique allows for consistent downstream consumption of the product bill to enable standard program management dashboards and foster an environment for cross-functional collaboration," stated Bayless. "Cross-functional participation in weekly product reviews, along with easily accessed data management by all program team stakeholders are keys to our success."

"Effective product data management provides program teams with the foundation for improvements with product costing, change management, part reuse, and configuration control," stated Lenny Grosh, PLM program manager for Mercury Marine.

For example, product data management within Teamcenter allows users to know product configurations throughout a program's lifecycle. For example, designers can lock down product structure at each of our major development milestones such as CV, DV, and PV. This provides the ability to compare build structures as the program matures.

Product data management in Teamcenter also provides a single location for the cross-functional product development community to collaborate and exchange information. This enables downstream collaboration by enforcing standardization in both data structure and processes that ultimately allows Mercury Marine to introduce more complex products to market faster with a smaller workforce.

Because products are not just a collection of independent parts, they are connected systems intended to channel energy using the paths and mechanisms designed by the engineers.

"To achieve the highest level of system refinement customers expect requires collaboration from everyone involved in the new product development community," emphasized Bayless.

Another example of a connection is how our change management system in Teamcenter works closely with our part reuse strategy. There is a step to screen common parts during the drawing sign-off workflow, so someone can review a proposed common part design before it is accepted and classified.

"Our classification gatekeeper has final say in whether a new part can be admitted into the Teamcenter Classification database," mentioned Nate Hering, document controller for Mercury Marine.

Part reuse has many product program benefits for Mercury Marine. For example, every new fastener adds complexity to the procurement, quality, and manufacturing operations for the following reasons:

- Costs to stock, procure, and validate new components
- Lost opportunity to improve the purchasing power of a component from increased volume

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"Most important, the time spent re-creating an existing or similar part for lack of knowledge is time not spent refining an all-new design," noted Bayless. "Wasting time on recreating common parts also takes time away from attending to product craftsmanship, which are the design details that really make a difference to the customer."

For example, Mercury recently launched an 8.2L inboard/ sterndrive engine – the only catalyzed big block gas sterndrive on the market. It was created in record time by making use of existing parts from a similar product from the Racing division. Leveraging existing brackets and fasteners was key to staying on timeline and budget.

The program was $100 under cost target, 10 hp above performance target, and part reuse was more than 60 percent. There were also craftsmanship goals assigned to the project, and having an efficient product management and part reuse strategy really help the team focus on what is important to customers.

These are some reasons why 'connectedness' is so important.

The interaction between program management, cost engineering, and how those work within a PLM deployment have been popular blog topics lately. Like many manufacturers, Mercury Marine has worked through challenges such as reconciling the CAD or PDM system design content with the ERP transactional data using Excel spreadsheets to manage new product programs.

While cost management is important to a program's success, it is just one facet. What often gets missed in all the fire-fighting, meetings, and organizational chaos is why the cost information isn't more easily available, or why it isn't populated sooner during a program. Plus, all time devoted to manual or semi-automatic data reconciliation takes away from the opportunity for cross-functional innovation.

Using the Large Assembly Management methodology as a foundation for managing the engineering bill of material allows other systems outside of Teamcenter to consistently access product structure and improve collaboration.

Effective product data management provides Mercury program teams with the foundation for improvements with product costing, change management, part reuse, and configuration control.

For example, the SharePoint-based Parts Planning Application (PPA) provides product teams with the ability to receive BOM structure changes automatically, along with attributes from Teamcenter, ProE, and ERP. Cross-functional team members can populate all program-related attributes using the Mercury Marine developed .NET application while having read-only visibility to all necessary design and ERP attributes.

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Review Attributes | Part Replacement | Remove Filters | Refresh Data | Export to Excel | Enable Tree View | Manage Views | Source Legend

Default View

Status	Seq Nbr	Level	Item ID	Item Revis	Item Name	Design Lead Accountable	Commodity Manager	Buyer	Quality Engineer	New/Current Part	Part Rank	Source	Primary Path Supplier
	0	0											
	82	5	8M0045865	01	COMPRESSION LIMITER	sanderso	landerso	cthuerwa	molivas	New		RE-Reference	Hengxin
	83	5	8M0035901	03	BREATHER FITTING	sanderso	landerso	cthuerwa	molivas	New		RE-Reference	Hengxin
	84	4	88552525	B	SCR-M6 X 25 HEX FLANGE HI	sanderso	rdstokes	wchapin	tkaczmar	Current	CP	P-Purchase	LSP
	85	4	8M0041011	01	OIL PUMP ASSEMBLY	sanderso	bkluge	ckonyn	dkijek	New	B+	P-Purchase	Mikuni
! NEW	86	5	8M0045945	01	BASE, OIL PUMP	sanderso	bkluge	ckonyn	dkijek	New		RE-Reference	Mikuni
	87	5	8M0045947	01	GEROTOR SET	sanderso	bkluge	ckonyn	dkijek	New		RE-Reference	Mikuni
! NEW	88	6	8M0045946	01	INNER GEROTOR	sanderso	bkluge	ckonyn	dkijek	New		RE-Reference	Mikuni
! NEW	89	6	896062001	-	ROTOR-OUTER	sanderso	bkluge	ckonyn	dkijek	New		RE-Reference	Mikuni
! NEW	90	5	8M0045944	01	COVER, OIL PUMP	sanderso	bkluge	ckonyn	dkijek	New		RE-Reference	Mikuni
	91	5	896067	-	PIN-DOWEL	sanderso	bkluge	ckonyn	dkijek	New		RE-Reference	Mikuni

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"By having the bill of material managed within ProE, then saved into Teamcenter and flow into the PPA for cross-functional use and reporting, the product teams avoid all the manual reconciliation and data population issues associated with an Excel-based solution," commented John Bayless, director of program management for Mercury Marine. "Users can easily pick which functional level of the bill to report against, interrogate, and simultaneously contribute to from any location, at any time globally."

Information is provided by all cross-functional contributes and allows everyone on the project team with instant visibility to the latest available information. This includes critical program metrics like product cost or weight roll-ups, or whether an important attribute like a drawing release date has been provided so purchasing can begin long-lead part procurement.

By doing this so early within the design concept stage, cross-functional teams can immediately start determining make/buy parts, establishing target costs, and identifying long lead time parts. Parts requiring tooling or special manufacturing processing are also identified and tracked early.

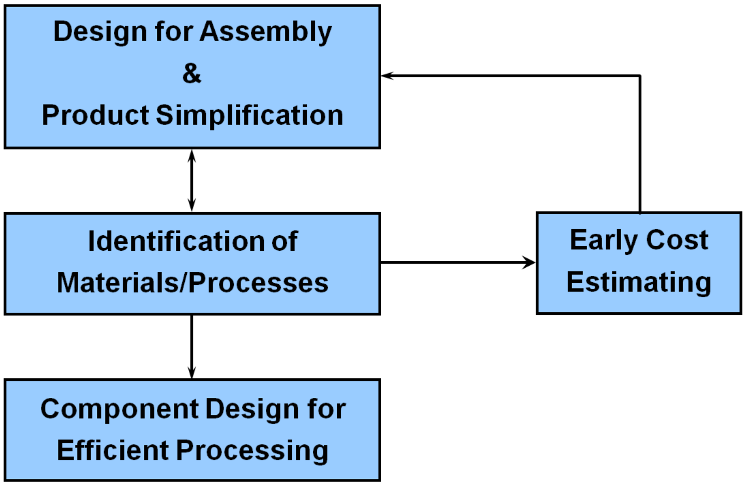
Program managers can open a single application (PPA) in SharePoint and know exactly how their program is performing. It also allows for more efficient team sessions because the meetings become more about providing status updates on progress, rather than resolving issues because the team members have proactively collaborated ahead of time.

This has the following benefits:

- Parts are here on time for development builds, and they assemble correctly the first time
- Collaboration among global cross-functional contributors is vastly improved, which helps program teams make better decisions faster, and early in the program
- Product quality is improved and attention to the details, or craftsmanship can be emphasized over fire-fighting
- At the earliest stages of product development, the design team populated a Target Cost into the PPA, which was used to develop a cost baseline and ultimately became the contracted cost bogey with management. As the design matures, engineers populate the Most Likely Cost, which is based on verbal quotes from suppliers or the engineer's experience.

"This is where PLM helps drive cost management," noted Bayless. "The standard Large Assembly Management methodology based on the functional partitioning of the workforce provides a consistent product structure across all development programs to drive BOM accuracy in addition to cost validation and reporting."

Another key component to the cost strategy is the introduction of BDI piece cost modeling with the Boothroyd–Dewhurst Design for Manufacturing and Assembly Software. This software has provided a detailed, benchmark-derived, customizable cycle time database for estimating piece cost with inputs that range from back of napkin design ideas up to ProE models.



Cost engineers begin using Cost modeling feedback during Concept Phase (CV) of engine development to help identify problem areas early to understand changes taking place on paper versus new tools.

The program team employed diligent data management to ensure consistent treatment of cost data, broken down to the lowest levels that allows for manipulation and presentation of data in various forms.

In addition, the cost team delegated the Cost Target to the functional system owners. Because the engineering teams are organized by function (base engine, electrical, drives, peripherals, etc.), it was logical to assign meaningful, aggressive, yet achievable cost targets to those design managers and commodity managers responsible for their area, as well as to challenge their engineers toward creative solutions.

"This cost management strategy involves relying on information from ERP for current part costs, then using an aggressive quoting strategy for new parts," stated Gordon Flores, cost engineering manger. "As quotes come in the team populates the Quoted Production Price attribute within the PPA that is tracked by design revision. This allows the

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team to know which revision of the part was quoted, the cost provided at that time, and to rank the risk dollars of that quote."

The Best Information Material Cost attribute, or the final product cost, is a calculated value within the PPA based the Quoted Production Price plus all applicable burdens stored in the PPA. The program team works toward having a firmed-up Best Information Material Cost by the end of the program Design Validation (DV) phase.

Finally, visual management provides consistent presentation of product cost information over time via weekly feedback of cost run charts for each functional partition using visual management powered by the PPA.

When combined, these cost management techniques provide product teams with early, accurate data in an easily understood format that enables better decision making throughout the product development process. Having access to information to manage issues at the earliest opportunity are critical.

By combining the large assembly and cost management disciplines, program teams have been able to consistently perform at, or under cost targets despite a new product launch cadence of every six weeks for several years.

Next, the product change management process helps keep people inside and outside of engineering informed as part adjustments occur. This helps people in quality, purchasing, and manufacturing work better with engineering and product managers to make the best possible product decisions for Mercury Marine.

"As a program manager, I have led my change board through some controversial changes." emphasized Bayless. "For example, I had an engineer recommend a change on a cowl seal for an outboard engine without regard to the capital budget. Luckily, the issue was resolved at the change board when the chief engineer suggested an alternative solution and the manufacturing engineer supported it with a lower-cost manufacturing option. In the end, we were able to meet the functional requirement and stay within the budget. Without the change board, we would not necessarily have had the opportunity to collaborate or the time within the program schedule to find an alternative solution."

To help better manage the changes, there are three change classes, Class A, B, and C. Class A changes apply only to new product development programs during CV and DV phase. Once a program reaches the Production Validation (PV) phase, changes are handled similar to production-released parts as a Class B type, which affects fit, form, function, and product cost. In the case of a class B change, the change initiator is asked to present their change proposal to the program-led Change Board that will decide how to proceed based upon the information provided by the requestor. A change board typically invites cross-functional, and cross-plant representatives affected by the change request to meet weekly.

"Having a smooth change process for the new programs really helps keep the program under control during the design validation phase," said Bayless. "In that regard, the change process has helped us maintain our cost, quality, and timing targets."

Mercury PLM Services Unique Perspective

Our differing approach concentrates on understanding your process as a must for success. A process-centric approach requires businesses to review and question existing work streams to understand "why," "what," and "how" work should be accomplished to establish efficient cross-functional work flows that are consistent, repeatable and scalable for growth.

We also offer a unique perspective for helping organizations considering a Product Lifecycle Management implementation because we view PLM from a manufacturing business-user's vantage point because we live and breathe it daily.

Because we work in a dynamic, global product-development environment that supports a worldwide manufacturing footprint, we have a user's perspective that helps drive results and realize improvements. Several of our experts also have been deeply involved with our ISO 9000 certification effort, as well as configuration management, and engineering document-management practices. Mercury PLM Services is a Siemens Zone SI Partner.■