Optimizing Product Realization Costs Across the Value Chain

By leveraging various cost optimization enablers, global automotive, aerospace, discrete manufacturing and medical device companies can identify and optimize costs holistically across the product lifecycle, thereby improving safety, environmental and regulatory compliance, sustainability and quality of products.

Executive Summary

Automotive, aerospace, discrete manufacturing and medical devices companies face numerous business challenges daily. Shrinking profit margins (due to unrelenting competition) and the movement of manufacturing to lower-cost regions are among the stiffest such challenges. Moreover, amid these escalating pressures, companies need to produce high-quality, differentiating products, while remaining cost-effective.

Each product development phase uniquely contributes to the company’s cost equation. However, most product development companies apply cost optimization initiatives to individual silos. To get more bang from these efforts, they need to embrace a holistic view of cost optimization across the product realization value chain.

This white paper identifies and addresses the various pain areas or factors contributing to cost overruns across the product realization lifecycle. The paper addresses the challenges within the four major phases of product realization in the value chain:

- Requirements and feasibility study.
- Design, verify and validate.
- Approve, manufacture and launch.
- Post-market observation.

Apart from the enablers/best practices in each product development phase, we also highlight key industry trends. In our view, early adoption of emerging solutions would help optimize product costs and enhance growth prospects.

Product Cost Optimization Challenges

Based on our domain and engagement experience, and discussions with multiple stakeholders across industry functions, we discovered the full sweep of factors that contribute to cost overruns across the product development lifecycle, and corresponding best practices to avoid such cost overruns (see Figure 1, next page).
### Cost Overrun Factors and Avoidance Best Practices

<table>
<thead>
<tr>
<th>Cost Overrun Factors</th>
<th>Best Practices to Avoid Cost Overruns</th>
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<tbody>
<tr>
<td>• Inaccurate or incomplete determination of VOC or VOB.</td>
<td>• Integrated quality management system that stresses active vigilance.</td>
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<tr>
<td>• Inadequate time spent on requirements management.</td>
<td>• Use analytics to preempt failures.</td>
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<tr>
<td>• Insufficient exploration of concepts and prototypes.</td>
<td>• Thorough root-cause analysis before re-releasing the product to the field after a recall.</td>
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#### Ideation: Requirements Management Stage

The successful realization and marketing of any product is dependent on capturing correct requirements as early as possible in the lifecycle. Faulty requirements during product development constitutes nearly 40% to 60% of total errors.

In our experience, cost overrun factors at the ideation stage include the following:

- The inability to accurately identify the voice of customer (VoC) and voice of business (VoB) at the start of the project, and inadequate time spent on requirements due to strict timeline commitments.
- Poor requirements and document-management practices.
- Neglecting process and documents to accelerate working product development.
- Lack of adequate dialogue with a regulatory authority at an earlier stage of product development - such as with the Federal Drug Administration (FDA) in cases concerning medical device development.

#### Product Realization Requirements

**Typical Product Realization Requirements**

<table>
<thead>
<tr>
<th>Design &amp; Risk Management</th>
<th>Sourcing &amp; Manufacturing</th>
<th>Interface</th>
<th>Performance</th>
<th>Product &amp; Data Security</th>
</tr>
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<tr>
<td>Service &amp; Installation</td>
<td>Labelling Documentation</td>
<td>Packaging &amp; Shipping</td>
<td>Usability</td>
<td>Regulatory</td>
</tr>
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**Figure 1**

**Figure 2**
Ideation Cost Optimization Enablers
Maintaining complete, correct, feasible and prioritized requirements within a requirements management system can help optimize costs (see sidebar below). Product lifecycle management (PLM) systems, for example, typically come equipped with requirements management capability, which helps to:

- Improve product quality and provide better traceability and risk management.
- Improve compliance to regulatory standards.
- Avoid rework and recalls, and ensure product is on time to market.

A PLM accelerator for socio-interactive automotive product development helps car makers acquire and apply social media feedback in a structured and meaningful way in their PLM systems during car platform development.1

Integrating systems-engineering capabilities into PLM improves collaboration between various departments of product development (mechanical, electrical and software design).2

Design/Verify/Prototype Stage
Design is another critical phase in the product realization value chain. Approximately 70% of the product costs are fixed during its design.3

Typical cost overrun factors faced by product development companies during the design, verify and validation phase include:

- Time wasted in iterations done during design, design prototyping and prototype testing.
- Inadequate attention to design for x or DFx (where x = manufacturing, testing, assembly, etc.) requirements.
- Designers unaware of how to focus on costs or their value attributes.
- Consideration for verification and validation activities after the requirements and design activities are completed.

Design Stage Cost Optimization Enablers
Product companies can adopt our knowledge-based engineering and VA-VE framework (see Figure 5, page 5) to effectively:

- Improve integration between computer-aided design (CAD), computer-aided manufacturing (CAM) and computer-aided engineering (CAE) systems.
- Optimize products using “what-if” scenarios.
- Improve time to market.
- Reduce, rework and reuse design knowledge.

Quick Take

Integrated Requirements Management for a Global Automotive Major

- **Business situation:** A global automotive major was using legacy systems to manage requirements. As a result, its engineers were spending an inordinate amount of time fetching data and managing requirements.

- **Solution:** A bidirectional integration of the PLM tool with the legacy system was developed. Earlier, the company used two-plus Java-based applications for requirements gathering, supplier management, manufacturing bill of materials control and CAD management. Using Teamcenter PLM, we were able to integrate all of those functions into a single tool and reduce the number of applications and approvals/signoffs, with improved visibility and transparency.

- **Benefits:** As a result of the integration, the automotive major could:
  - Easily maintain, manage and fetch the required information with regard to standards and regulations.
  - Conduct root-cause analysis with reduced lead time.
  - Reduce the number of applications.
  - Increase operational visibility and transparency.
  - Manage regulatory and standard-process-related information in a centralized repository.
Quick Take

Automated Design Verification and Validation at a Global Automotive Major

- **Business situation:** A global automotive major was using a traditional and manual process for design verification and validation. As a result of this traditional process:
  - Time was wasted in repeatable work during design and prototyping.
  - Design knowledge was lost when employees left the organization.
  - There was an absence of design verification and validation standards.
- **Solution:** A proven, knowledge-based engineering framework was implemented that automated the CAD-based verification and validation process.

- **Benefits:** As a result of automating the verification and validation process, the automotive major has:
  - Increased efficiency and productivity, and improved quality via repeatability and reproducibility.
  - Re-stratified and effectively used engineering manpower.
  - Effectively integrated its CAD and enterprise information systems.
  - Separated decision support from decision-making activity.
  - Made product creation process automation the primary driver.
Our Approach to KBE-Design Automation: CFAD

![KBE System for Design Automation]

Capture of Engineering Knowledge
- Knowledge acquisition through reports, design, manufacturing, performance and maintenance functions.
- Captured knowledge from business to maintenance activities & modeling techniques.
- Use of spreadsheet for capturing knowledge by implementing equations or rules that enable knowledge recycling.

Knowledge Formalization
- Interpretation of acquired knowledge into rules and formalization to a computer-implementation-friendly format.
- Formalization using a partner-company approach. During this activity the implementation structure - i.e., a hierarchical class structure - takes shape.

Automation of Engineering Activities
- Implementation captured process, rules & activities to develop a KBE tool.
- Follow iterative process between the capturing of engineering knowledge and the automation of engineering activities.

Deploy Quality Control of Engineering Activities
- Testing of tool and/or application by allowing engineers to design the lifecycle properties of the product.
- Packaging & deployment of the tool.

Our VA/VE Framework: SMART

![SMART Diagram]

Problem Statement
- Understand customer needs.
- Define “as is” and “to be” condition in measurable terms.
- Project charter.

Measure
- Define the defects or issues.
- Gather baseline information.
- Critical to quality customer requirements.
- Process map.

Analyze
- Analyze info/data collected for evaluation.
- Identify top contributors for defects or issues.
- Set goal for improvements.

Reengineer
- Develop concepts/ideas for better design.
- Finalize ideas and perform detailed design engineering.
- Perform cost analysis.

Test & Validate
- Validate design using CAE analysis.
- Build functional prototypes.
- Measure performance of new design.
PLM integrated 3-D shape search helps designers in identifying parts of similar shape in the enterprise databases. As a result, companies can save time by avoiding rework. In the medical device industry, 3-D printing is another instant prototyping technology that has proven to be revolutionary. With the use of 3-D printing, surgeons can design implants and instrumentation specific to each patient. When doctors need to create a new device on demand for rare, unpredictable conditions, 3-D printing is applied.

Manufacture
Manufacture and launch is another critical phase in the device lifecycle. While requirements and design set the foundation for a successful product launch, costs incurred on manufacturing and the supply chain can make or break a product launch. Hence, cost optimization in manufacturing is of prime importance. The factors that contribute to cost overruns in this phase include:

- Increase in raw materials cost.
- Selecting single source for long-lead items.
- Poor data quality in device trials and on road testing.

Manufacturing Stage Cost Optimization Enablers
Three enablers can be implemented for cost optimization at the manufacturing stage.

- **Optimize**: Planning and approaching the manufacturing phase using optimization tools for raw materials optimization as well as costing and supply chain optimization.
- **Control**: Use of quality control techniques such as Six Sigma and Lean manufacturing to effectively reduce quality-related issues of the devices produced.
- **Produce**: Working with contract manufacturers by sourcing design, manufacturing or delivery to OEMs.

Cost Optimization Enablers: Manufacturing Phase

![Cost Optimization Enablers: Manufacturing Phase](image)

The integration of manufacturing with product development using analytics and big data helps designers to take corrective and preventive actions based on inputs from manufacturing engineers.

Post-Market Stage
Product development companies spend billions of dollars on product recalls (warranty- or compliance-based). The cost of poor quality affects the image of companies and erases profit earned - due to litigation costs. Poor quality also endangers the lives of customers.

Companies face huge warranty-, compliance- and safety-related issues, while automotive companies regularly face warranty and safety issues with regard to various components. The causes:

- Inefficiency and a lack of proactive vigilance.
- Ineffective root-cause analysis.
- Incomplete addressing of issues.
• Aging complaints and corrective actions preventive actions (CAPAs).

**Integrated QMS and PDLC**

![Diagram of Product Realization Value Chain Aspects]

**Post-Market Cost Optimization Enablers**

In our view, an integrated quality management system (IQMS) can bring additional organizational effectiveness. Companies that have implemented IQMS achieve better on-time shipment rates. Moreover, integration adds quality control from conception through post market, and brings more effective cross-functional collaboration (between the design and quality departments, for example). As a result, quality issues at the design level can be addressed very early in the process.

Other benefits of IQMS include improved organizational effectiveness, successful new product implementation (NPI), increased compliance, reduced internal and external failure costs, and reduced quality prevention and quality assurance costs.

Automotive companies are now looking at an integrated approach to collecting vehicle information using Internet of Things (IoT) technologies and connected vehicles to actively monitor and advise customers on likely quality issues.²

**Going Beyond**

Any cost optimization initiative without the ability to view cost metrics is of little use. Enterprises typically do not visualize the benefits and ROI of a cost optimization drive in a holistic way. A single source of truth is necessary for analyzing or viewing product costs, which can be obtained through a cost analytics and reporting tool that can communicate insights holistically across the organization or enterprise.

An enterprise cost reporting system should be able to:

• Interact with all enterprise systems and departments.

**Quick Take**

**Product Cost Management at a Global Automotive Major**

• **Business situation:** A global automotive major was using a traditional system of product costing:
  > CAD data moved between various departments such as design, sourcing and costing through e-mails.
  > Engineers did not have the most recent CAD data for costing purposes.
  > Delays in design changes due to cost overruns led to product rollout delays.

• **Solution:** A CAD-based costing tool was developed that automatically generates tool and manufacturing costs based on recognition of CAD features.

• **Benefits:** As a result of an integrated PLM/CAD costing tool, the automotive major now can:
  > Get real-time cost information at every stage of the product lifecycle.
  > Broadcast a single source of truth with regard to cost.
  > Negotiate better with vendors with regard to parts costs.
  > Help designers know the cost implications of their designs, instantly.
• Track and analyze cost for various product configurations.
• Report cost data across the enterprise.
• Search and identify various cost components with ease.

Looking Forward
Any effective product cost optimization program is an amalgamation of effective people using efficient tools to drive effective processes. Product cost optimization is a by-product of efficiency and a never-say-die attitude embedded in an organization’s culture.

Today’s product teams focus not only on products’ features and their performance, but also on cost, safety, environmental and regulatory compliance, sustainability, quality and other factors that impact the design process.

Continuous monitoring of cost across the product realization value chain can help identify key cost drivers. With this knowledge, a product design team can deploy control measures to optimize costs through multiple tools and methodologies, as discussed in the paper. Enterprise product cost optimization brings the focus on creating a win-win outcome for product development companies and their suppliers, at an optimum cost for customers.
Quick Take

Proactive Vigilance in Medical Device Quality Management Systems

A working QMS is part of reactive vigilance which triggers a chain of events back to the PDLC only when quality issues are discovered in the product. Such vigilance would provide valuable learning that would ensure quality issues are addressed proactively.

Medical device companies should be encouraged to go a step further and be proactive in following product recalls or incidents of other competitors in the same product category.

Footnotes


Reference

- Requirements Management: The Interface Between Requirements Development and All Other Systems Engineering Processes, by Colin Hood, Simon Wiedemann, Stefan Fichtinger, Urte Pautz; Springer, 2008.
About the Authors

Madan Unde is a Senior Manager of Projects within the Product Engineering Practice of Cognizant’s Engineering and Manufacturing Solutions business unit. He has over 13 years of engineering industry experience, working in both the engineering OEM as well as engineering services spaces. Madan's work experience spans industries, from life sciences (medical devices), high-technology, and industrial automation, through machine tools. In these roles, he has provided solutions across various technical areas such as product design and development, innovation (front end), continuous improvement, complaints investigation and resolution, CAPA management and product sustenance engineering. Madan is well acquainted with medical devices standards such as ISO13485 and ISO14971, and practices such methods as Six Sigma, DFx, risk management, and value engineering/value analysis and problem solving. Madan holds a mechanical engineering and industrial engineering post graduate degree from the University of Pune and is a certified Six Sigma Black Belt Professional (MSME India) and Value Engineering Associate Value Specialist (SAVE & INVEST). He can be reached at Madan.Unde@cognizant.com.

Murali Krishna is a Manager of Projects within Cognizant's Engineering and Manufacturing Solutions business unit. He has 11-plus years of experience in building CAD-to-CAE and CAD-to-CAM data interoperability solutions, product cost management, geometric search and knowledge-based engineering solutions. Murali has vast experience in creating frameworks for automotive design verification and validation. He has worked extensively with automotive, high technology and manufacturing companies to provide the best solutions for their data interoperability needs. Murali has authored technical papers in the fields of CAD, CAM and CAE. He has a bachelor’s degree in mechanical engineering from College of Engineering, Guindy. Murali can be reached at Muralikrishna.AV@cognizant.com.

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