

How to go from Concept to Customer: Best Practices in Product Delivery

**Cheryl Tulkoff, Randy Schueller,
Greg Caswell and Jim McLeish**

Introduction

Having a comprehensive review methodology for Product Delivery Processes (PDP) is very beneficial to an engineering development activity in that it involves the entire product life cycle from product design to manufacturing to delivery. Herein, DfR has provided a guide into the various phases and steps that should be elements of such a process. Doing so will provide you with a means to evaluate your processes, determine their effectiveness and efficiency and benchmark them against current industry best practices and organizations.

DfR has prepared a step by step methodology to map out a PDP program and benchmarking analysis that will help you, the user, to ascertain these best practices with respect to your internal engineering and management operations. The defined activities may also provide insight into methodologies for reducing costs. Following the described activities in this document will result in a highly collaborative organizational efficiency for your company that will evolve as interaction progresses and recommendations for further improvements are developed.

Benchmarking

The first step in developing a viable PDP process is establishing a baseline where activities can be benchmarked against relevant industry capabilities, activities, and performance.

Benchmarking is a systematic process for evaluating business processes and performance metrics against the best in class performers in your industry and/or proven best practices from other industries. Benchmarking is a way to measure how well an organization is performing via comparative evaluations. An additional objective of benchmarking activities is to set standards, goals and plans for improving processes that lead to improved organizational and business performance.

There is no single objective, approach or focus in benchmarking. Examples of metrics that can be selected for evaluation in a benchmarking activity are quality, reliability, execution time, efficiency, or throughput, cost and return on investment. Examples of the type of issues benchmarking can focus on are:

- **Process Benchmarking** - investigation of primary business processes such as engineering, manufacturing, customer service, etc.
- **Product benchmarking** - evaluation of the capabilities, performance, quality, manufacturability and cost of tangible physical products or intangible services, often by reverse engineering.
- **Financial Benchmarking** - uses financial analysis to evaluate competitiveness and productivity.
- **Business Function Benchmarking** - focus on back room overhead functions such as human resources, finance, accounting, sales, marketing, information technology and logistics.
- **Best-Practice or World Class Benchmarking** - comparison against widely accepted, academic or theoretical ideals for the purpose of becoming “World Class” rather than merely competitive.

Any benchmarking activity should not be limited to simply competitors. The activity of organization used as the benchmark subject can include:

- **Internal** - between business units to facilitate cross divisional learning and sharing.
- **Competitive** - to evaluate capabilities against competitors.
- **Functional** - to evaluate similar processes between unrelated industries. Similarities can be in regards to product complexity, product volume, and criticality/reliability expectations

The approach to benchmarking can also vary, with either a **direct** approach, involving direct contact, visits and exchange of information (rare between competitors), or **indirect**, which uses evaluations based on publicly available data and publications.

The greatest benefits are usually achieved by benchmarking organizations in different industries that perform similar functions. This approach offers the potential to cross pollinate new ideas across traditional industry boundaries. The benchmarking should be performed in parallel with the organization evaluation (defined in the next section) so that as key organizational issues are identified they can be used to define the scope and focus of the benchmarking activity.

Organizational Review of Processes and Systems

An organizational review involves a comprehensive assessment of an OEM's processes and systems that influence product quality and reliability. The evaluation is organized into four phases that emphasize the particular OEMs issues of interest:

- 1. Product Development Processes**
 - 1.1. Identify user's needs
 - 1.2. Product development processes,
 - 1.3. Design change implementation
- 2. Supply Chain Management Processes**
 - 2.1. Supplier selection process,
 - 2.2. Supplier product qualification process
 - 2.3. Supplier management and monitoring
- 3. Manufacturing Processes**
 - 3.1. Manufacturing Process Development,
 - 3.2. Manufacturing Transfer,
 - 3.3. Manufacturing Test & Quality Control
- 4. Product Delivery**
 - 4.1. Shipping
 - 4.2. Product training
 - 4.3. Customer receipt & product preparation
 - 4.4. Product Verification
 - 4.5. User Education
 - 4.6. In field performance tracking

Evaluation Phase 1 – Product Design Process Review

As the first phase of a PDP review, DfR recommends that you first evaluate your product development processes by developing an understanding of the tasks, steps and procedures used. To achieve this, DfR recommends modeling the process as an “Engineering Factory” that produces new products. This enables the creation of an engineering process flow diagram similar to a manufacturing process flow diagram, where the key steps in the overall engineering process (both internal and outsourced) are modeled like work stations in a production process.

Modeling a Design/Development Engineering process in this manner enables identification of the overall efficiency, complexity and thoroughness of the process and provides a tool for illustrating where additional steps could be added, or how the process could be reconfigured to improve efficiency or effectiveness. The Design/Development Engineering phase of the project focuses on evaluating the current engineering organization and the tools and engineering life cycle processes used to create a new product. Examples of the type of process steps and tasks that can be considered are:

Technology and Market Research Activities

Concept development

Requirement Development and Creation.

Risk Based Design – Margin Analysis

FMEA

Electronic Circuits Design & Analysis

Circuit Board Layout

Design and Analysis of Packaging & Integration

Design of Wiring & Connector Systems

Software Creation & Coding

Simultaneous Manufacturing-Design Integration (i.e. Design for Assembly)

Prototyping

Physical Testing - Development

Physical Testing - Performance

Physical Testing - Reliability/Durability

Software Development & Testing

Software Fault Tolerance & Robustness Testing

Regulatory Certification

Design of the Manufacturing/Assembly Process

Error Proofing

Quality Control Process

Supplier Quality

Continuous Improvement Processes

Six Sigma Quality Objectives.

Review Process

The proposed steps of the review process are:

- 1) Scope Preparation and Planning
- 2) Onsite Current Process Assessment
- 3) Organizational Evaluation and Process Follow up
- 4) Finding Documentation and Recommendation Development.
- 5) Findings and Recommendations Report Presentation

Scope Preparation and Planning

During the initial preparation and planning phase DfR recommends that you gather information such as organization charts and existing process definition documents to understand the current state of your product design, development, qualification and reliability processes selected for the evaluation (reference the example task list in section 2). DfR Solutions then recommends that these materials be reviewed to ascertain the breadth and depth of the current documentation and to create an evaluation worksheet for each item, task or department being evaluated.

The timeline for each phase of the organization review will depend on the number of processes to be evaluated and the ability of your organization to provide the required documents and schedule the required meetings and review activities.

Onsite Current Process Assessment

Following the collection of the appropriate documents, DfR recommends an in-depth review of the selected current processes. This will entail a kick off meeting with management involvement to be followed by smaller meetings with the personnel involved in the selected processes, to perform the preliminary process evaluation and fill out the evaluation worksheets. Examples of issues to be evaluated are:

Review of Internal Design Specifications.

To understand the development and transmission of internal design specifications, DfR recommends a review of internal design specifications for a selected product line. Areas of inquiry may include:

- Do internal specifications adequately define the field life stress conditions the product is expected to endure?
- How are reliability requirements specified?

Review of Engineering Design Processes and Design Controls

To capture the extent of design processes and design controls and how these design elements evolve within the organization, DfR recommends a review of the current engineering process.

Areas of inquiry may include:

- Is design for QR&D and robustness incorporated into the process?
- What is the software design/engineering process?
- Are design engineers aware of typical electronic failure mechanism and how to prevent them?
- What design analysis tools/methods are used (i.e. CAE, FMEA)?
- What kind of peer or management design review is performed and what items are evaluated?

QRD Data Feedback Systems

To understand organizational awareness of current QRD+P improvement opportunities DfR recommends a review of the current manufacturing quality and field data collection analysis capabilities. Areas of inquiry may include:

- How are product improvement opportunities identified and prioritized?
- How are issues on various product lines that need QRD+P improvements most often identified?
- Improvements refer to both resolving current discrepancies and permanent corrective action to the systemic issues that enable the problem to manifest itself and avoid detection.
- Are the differences between quality/defect related problems, design durability, wear out problems and over-stress issues understood?

Review of Validation Test Procedures,

The next step involves a review of test procedures to evaluate where tests are performed in the PDP, how testing is justified, and how test results are fed back into engineering activities and management awareness. Areas of inquiry may include:

- Are both performance and life/endurance testing issues evaluated?
- Are life/endurance tests designed to only duplicate environmental conditions or are the tests designed to activate failure mechanism/evaluate failure mechanism susceptibility in the most effective manner possible by means of applying Physics of Failure principles?
- How is software validation performed?
- Is software fault tolerance, fault recovery and robustness evaluated?

Organizational Evaluation and Process Follow Up

Information collected on the process evaluation worksheet to form the engineering process flow diagram will illustrate how the various processes and department interact with each other. During this phase there may be a need for internal follow up activities and questions to fill in any gaps that might emerge.

Findings Documentation and Recommendation Development

After the organizational interactions are identified the best and most efficient/effective QRD features in the current configuration of the system should be identified and documented. Opportunities for improvement should also be identified and recommendations for improvement developed. The finding, conclusions and recommendations should be documented in both a detailed report and executive summary to provide management with the requisite information. DfR recommends that this data be provided in a prioritized list.

DfR Solutions has extensive experience in providing PDP support to their customers and has an open door policy to answer questions arising from your implementation of such a structure. Feel free to contact us with any questions that may arise.