



# DFX Deployment – Leveraging Business to Increase Profitability

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## Overview

How can the products we develop generate maximum profits for our company?

Globalization, stiff competition, and customized products have become the norm in our business environment, driving far-reaching changes in the product development processes.

Companies introducing new products to the market therefore face the following challenges:

1. Sophisticated customers with highly focused demands.
2. New product teething problems and unforeseen faults.
3. Dependence on development, manufacturing, integration, forwarding and transportation suppliers.
4. A myriad of regulations, primarily relating to safety and environmental regulations.

The main consequence of these challenges experienced by companies is a steep rise in operating costs from manufacturing, assembly, conveyance, installation, service and maintenance. In some cases, these expenses may exceed overall profits from sales of the new product in the initial years of market penetration. This trend is now forcing development units to shift their focus from complex product design to ensuring that the product complies with functional requirements. As a result, it has become imperative to create products which are inexpensive, fast and convenient to manufacture, assemble, transport, service and use.

This type of design is known as **Design for X**, or **DFX** for short.

## How is DFX implemented?

The adoption of DFX in a company requires end-to-end action by all layers of the corporation, as illustrated below:



### 1. Management commitment

This vital factor underpins the deployment of DFX and provides the business leverage to increase company profitability.

The corporation as a whole needs to adopt a culture of close collaboration between development, operations, service and quality. Development personnel are no longer the exclusive owners of product development, but instead become the party to lead the development process. They must remain in constant consultation with other parties and take their opinion into account, while those parties gain power and sway over product advancement for the subsequent stages of development. This step has far-reaching consequences for the enterprise, from a possible impact on the timetable to cultural changes such as concurrent engineering.

Such changes in corporate culture require an unequivocal and active commitment on the management's part, making it absolutely clear that these are the new rules of the game in this company.

### 2. DFX processes

In order to implement DFX, detailed work processes must be defined, focusing on a range of principles:

**Interfacing of the DFX processes to the PLC (Product Life Cycle) processes in the enterprise**

**Creating integrated engineering processes across the enterprise**

**Collaborating with the relevant content experts from the initial development stages, including constant feedback**

**Traceability between the definition of the DFX requirements and control of their implementation throughout progress on the development work**

**Defining informed decision-making processes based on the weighting of the various DFX aspects according to cost-benefit considerations**

*(For example: selecting highly reliable components will improve the design for reliability but at the same time hurt the design to cost)*

### 3. DFX guidelines and templates

In order to implement the DFX process and achieve adherence to the above principles, various tools are needed. These will be used primarily by development personnel but also by content experts for control purposes.

Checklists are the first and most basic tool required.

The checklist incorporates the **Development for X** principles, whereby **X** stands for manufacturability, usability, serviceability, reliability, etc. This tool helps coordinate expectations between development personnel and content experts and encourages the designer to focus on creating a more DFX-type product.

Another tool, mainly for the project manager, is the trade-off tool, used to make informed decisions based on parameters, such as the impact on the product price, its performance, customer satisfaction, time-to-market, etc. This tool enables the project manager to define the key parameters for each case and then use them to reach decisions.

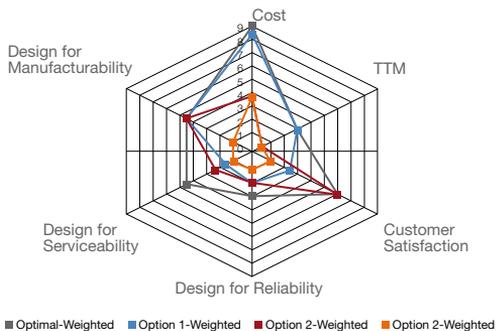
Additional tools largely consist of templates that define how DFX is addressed and how it is presented at DRs, PMRs, and other significant points along the development process.

Examples of tools developed by Tefen for a client in the semiconductors industry:

A checklist:

#	Related DFx	Owner	Requirement	Description	Relevant DR	Element Status
<b>1</b>						
1,1	DFMA	Manufacturing	System's Concept Manufactureable Concept	Integration CT differential target should be defined and verified, break down to sub systems integration time can be used	CoDR	Comply
1,2	DFMA	Mechanics	Manufactureable Concept	Mock-ups and prototypes are recommended for DFMA feedback	PDR	Not comply
1,3	DFMA	Mechanics	Manufactureable Concept	Present tolerances overall budget	CDR	Open Issue
<b>2</b>						
2,1	DFMA	Engineering	Manufactureable Concept	Machine assembly should be based on existing facilities and not require new or non-standard tooling/facilities	PDR	Comply
2,2	DFMA	Mechanics	Manufactureable Concept	Maximum (according to project definition) backwards compatibility	CoDR	Comply
2,3	DFMA	Mechanics	Manufactureable Concept	Using shelf parts, consider part MTBF and EOL commitment	PDR	N/A
2,4	DFMA	Mechanics	Manufactureable Concept	Module dimensions comply with manufacturing facility & transportation	CoDR	N/A
2,5	DFMA	Mechanics	Manufactureable Concept	Transportation package design	CDR	N/A
2,6	DFMA	Mechanics	Manufactureable Concept	Returnable packaging. If packaging is one time package it should be recyclable	CDR	N/A
2,7	DFMA	Mechanics	Manufactureable Concept	Use standard assembly tools, threads, cutting tools, gauges, etc (minimum special processes)	CDR	N/A
2,8	DFMA	Mechanics	Manufactureable Concept	Maximize communality of parts and components	CDR	N/A
2,9	DFMA	Mechanics	Manufactureable Concept	Sub-system dismantling will require dismantling of minimum number of parts	CDR	N/A
2,10	DFMA	Mechanics	Manufactureable Concept	Min. tools will be needed while disassemble parts from machine, not more than....	PDR	Open Issue
<b>3</b>						
			<b>Manufactureable Design</b>			
			<b>Technical requirements</b>			
			<b>Testability</b>			
			<b>Supply Chain aspects</b>			

Trade-off results: examination of two development options:



The teams should then collaborate to define the tools, with the content experts responsible for providing the professional content and the development representatives responsible for approving and validating the tools built. It is vital that a team charter is defined for each team, specifying the team members, its goals and its main deliverables.

4. DFX practice teams

In order to define the various tools, we recommend that teams of representatives from the various disciplines are formed. For example, a team charged with building tools for DFS (Design for Serviceability) should, at the very least, include members of the various disciplines in the development unit and service representatives from the enterprise.

Produce DFMA tools, guidelines and processes to be implemented and validated within the XXX project

Team's goal

- Brain storming meetings
- Checklists, processes and templates preparation

Main Activities

- DFMA Guidelines Checklist
- DFMA implementation process
- Template for DFMA in PLC gates
- Template for in DR
- Trade-off tool

Deliverables

- Amit
- Omer
- Ofek
- Alon
- Gilad
- Sagi

Team Members

Integrated teams are also very important because they develop an atmosphere of openness and mutual cooperation, creating agents for change, the backbone for implementation of the processes and tools.

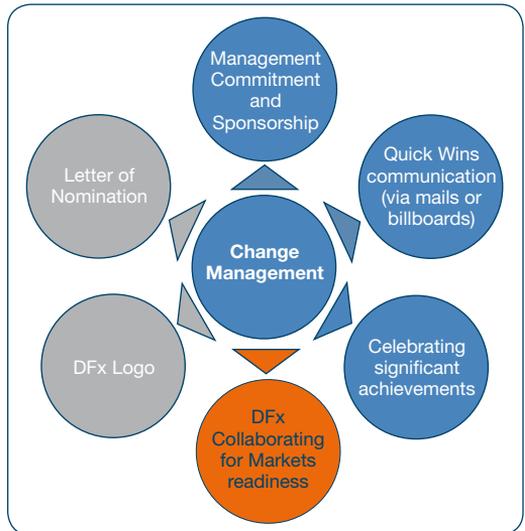
**5. Change management**

Change management activity is essential for implementing a company-wide DFX process. The purpose of change management activities, such as those listed below, is to set the tone of a new, significant process that will contribute to product maturity and take the corporation forward:

- **Creation of project logo:** creates a sense of identification with the process – all communication relating to the process is clearly identified. Choose a logo that emphasizes the core principles of the process, as perceived by the enterprise: collaboration, professionalism, corporate expertise, etc.
- **Letter of nomination:** all those involved in the process, in particular the members of the various teams, receive a letter of nomination which clearly defines what is expected of them throughout the process, the importance of the process itself and of their personal contribution to it. This letter must be signed by a senior management representative (such as VP Development).
- **Quick wins:** it is important to create significant changes and successes with minimum effort, early on in the process. For example: making a design improvement that makes a component much easier for service personnel to repair, should the need arise, or inserting significant requirements in the SOW which obliges the supplier to deliver a product with greater manufacturability, serviceability and reliability. Every success, however small, must be communicated to the corporation as a whole, especially to those involved in the process.
- **Celebrate significant achievements:** we cannot stress enough that each and every positive achievement in the process must be communicated and highlighted, in order to address and diminish any resistance.

- **Management commitment:** as we have explained, this is a basic prerequisite for starting the process. In practical terms, this means:
  - A senior management representative (company CEO/ VP Development) sends an e-mail, setting out the process and announcing its kickoff in the enterprise, while listing the anticipated benefits from it and the fact that enterprise management is committed to the process.
  - Participation by a senior management delegation in key process milestones, etc.

Additional activities could include producing a special newsletter on the subject with professional articles flanked by photographs from team meetings.



**6. The DFX roadmap at the departmental level**

To ensure that an extensive deployment of DFX throughout a corporation is successful, it is important to define the stages that each department/discipline must go through. To this end, we recommend preparing a roadmap with the main milestones in the process, so that the progress of each individual department can be tracked, any difficulties can be identified and the deployment status of the overall process can be easily examined.

**Example of roadmap prepared by Tefen for a client in the printing industry:**

DFx	Phase	Team Kick.Off	Gap Analysis Finalization	Tools Creation	Templates Creation	Processes Definition	Training needs Definition	KPIs Definition
Serviceability		Mar-12	Mar-12	Jun-12	Jun-12	Jun-12	Jul-12	Jul-12
Usability		Apr-12	Apr-12	Jun-12	Jun-12	Jun-12	Jul-12	Jul-12
Manufacturability & Assembly		Apr-12	May-12	Jun-12	Jun-12	Jun-12	Jun-12	Jun-12
Reliability		May-12	Jun-12	Jun-12	Jun-12	Jun-12	Jun-12	Jun-12

**7. DFX pilot projects**

Due to the workload involved with implementing a DFX process throughout an entire organization and the enormity of the impact on the company, we advise that you start by introducing the process in a limited number of pilot projects.

**Selecting a pilot project**

It is best to select a project that is in its preliminary stages (concept):

A cooperative Project Manager, that acknowledge the importance of the DFX issue

Not too big or complexed, so it would be easier to guarantee success

A significant and strategic project so that the required resources would be supplied

It is easier to build a process infrastructure and a different work culture when a new team is involved

Which includes significant logistic or service aspects

The DFX requirements can be defined immediately at the start of the project

No need to go back and execute stages of a project again

**Pilot success is very important**

An unsuccessful pilot could cause a negative reputation for the DFX process, which would then make it virtually impossible to persuade the organization to implement the DFX process again. Note that the DFX pilot does not have to be a full system – a significant module or sub-system can also be selected for that purpose.

**8. DFX trustees**

We recommend nominating DFX trustees to disseminate the DFX process in the enterprise. These trustees are key representatives from every project or practice team, who are committed to the process.

- Agent of change
- Serving as a knowledge center in the area
- Work in accordance with DFX processes

**9. DFX metrics**

To examine the success of the DFX deployment in the enterprise, a series of indicators (KPIs) needs to be defined in advance. Let us look at two types of metrics: ones which indicate the extent of DFX deployment in the enterprise and ones which show the DFX requirements in the specific project.

The following is a partial example of possible metrics addressing both the process and the product:

**DFx requirements for product**

- Item Lead Time
- % of identical parts in previous products
- Bill of Material Cost
- % coverage of pass/fail tests
- Product Cycle Time
- Automatic diagnostics processes in Field Replacement units
- Mean Time Between failure
- Mean Time To Repair
- Simplicity of the user interface

**DFx processes**

- Definition of the Dfx requirements
- Existence of engineering processes in the project
- Presenting of the Dfx status at Design Reviews
- Dfx tool in use
- Information systems that support Dfx
- Average Dfx score for the project

Other metrics can be added to examine knowledge management or authority:

- How many employees have received instruction in DFX
- How many course cycles have been held
- The quality of the instruction materials.
- Etc.

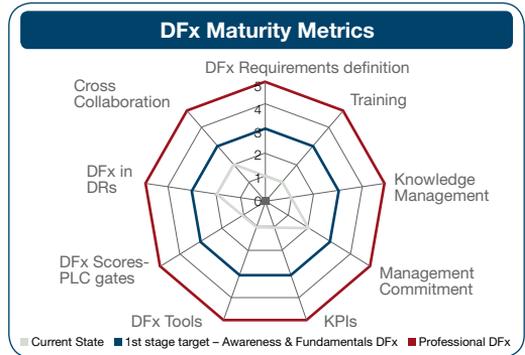
## Tefen model for assessing the DFX maturity level in a company

The first stage in a DFX assessment necessitates an examination of the existing situation and the extent of the enterprise's readiness to define and effectively implement the DFX culture and methodology. To this end, Tefen has developed a model consisting of five levels of maturity that addresses various aspects of implementing DFX in an enterprise and enables formulation of an operative and efficient action plan to implement DFX at the most suitable level. The five levels are:

- 1. Awareness:** general awareness of how important the issue is, few concentrations of knowledge in the enterprise, no defined process for deployment, projects free to address issue or not, management policy supports implementation of DFX but does not mandate it.
- 2. Process:** management is committed to preliminary implementation of DFX, a highly flexible process has been defined, a very limited proportion of projects are required to implement a preliminary DFX, without metrics, and with only basic tools (Office templates).
- 3. Control:** the foundations of processes and tools for implementing DFX exist at a deeper level, a knowledge center has been established, integrated engineering has been

deployed, the subject is communicated, basic tools are used, support from professional instructors exists, metrics exist, and approximately half of projects deploy DFX.

- 4. Governance:** management is very strongly committed to the subject, metrics are defined and deployed, advanced tools are used, instructional training extends across the organization, targets exist at the level of every department and project, and most projects deploy DFX.
- 5. Culture:** the processes are fully deployed in all projects, a culture of collaboration and continuing improvement exists, DFX is a key element in the decision-making process throughout the product lifecycle, management is totally committed, and advanced computer-based tools are used.



Subject	Level	Awareness & Fundamentals DFX		Professional DFX		
		1	2	3	4	5
Processes	<b>DFX Requirements definition</b>	Basic DFX requirements defined	Partial DFX requirements defined	Partial DFX requirements defined	Full DFX requirements defined	Full DFX requirements defined and derived from the business goals and budgets
	<b>Core Teams existence</b>	10% of the new modules have active core teams	25% of the new modules have active core teams	50% of the new modules have active core team	75% of the new modules have active core teams, core teams process included within the company PLC	All new modules have active core teams, core teams process included within the company PLC
	<b>DFX in DRs</b>	Partial representation of DFX on DRs	Partial representation of DFX on DRs	Partial presentation of DFX on DRs	Full presentation of DFX on DRs, DR process included within the company PLC	Full presentation of DFX on DRs, DR process included within the company PLC
Tools	<b>DFX Scores - PLC gates</b>	No DFX gates definition	No DFX gates definition	There are Min. definitions for DFX score on PLC gates	Project partially meet the DFX score per PLC gate	Project fully meet the DFX score per PLC gate
	<b>DFX tools</b>	No DFX tools	Basic DFX templates (requirements, spec, DRs, testing procedures, lessons learned)	Guidelines and templates	Monitoring and control tools	Trade off tools
	<b>KPIs</b>	No defined KPIs	KPIs are defined but partially implemented	KPIs are defined but partially implemented	KPIs are defined and implemented	KPIs are defined, implemented and continuously improved
Change Management	<b>Management Commitment</b>	Management is aware of DFX importance	Management is aware of DFX importance and requests managers to present their plans and progress	Management is aware of DFX importance, change management and continuous communication are implemented	Management is aware of DFX importance and approves delays in order to complete DFX requirements	Management is aware of DFX importance and approves delays in order to complete DFX requirements
	<b>Knowledge Management</b>	Knowledge exists but not managed	Knowledge exists but not managed, DFX knowledge trustees are nominated	Knowledge is documented and managed, DFX knowledge trustees are nominated	Knowledge is documented and managed via dedicated organizational portal, practice teams per DFX elements exist and provide common methodologies and continuous improvement	Knowledge is documented and managed via dedicated organizational portal, practice teams per DFX elements exist and provide common methodologies and continuous improvement
	<b>Training</b>	No training plan	Basic training plan is established	Partial trainings take place	All training needs are addressed	On-going continuous improvement

## Implementation of DFX Processes in Industry

### Dell Case Study(\*)

#### Background

Dell Computer Corporation (Round Rock, Texas), the world's leading direct computer systems company, has long been recognized as a provider of easily serviced, readily installed, customized computers. By 1998, Dell was associated as well with something else – an explosive growth 2.5 times the industry average. Instead of adding facilities and people, the company took a less-expensive route: **it redesigned its products to make them easier and faster to assemble and to service.**

#### DFA and DFS Goals

Create **commonality** throughout a product line

**Reduce purchased part count at least 17 percent** and **mechanical assembly time at least 25 percent**

**Reduce screw-type count at least 67 percent** and screw min/max count at least 20 percent

Make the product even **more service and customer friendly** by reducing average service time by at least 25 percent

Dell accomplished all of these goals through a methodology known as Design for Assembly (DFA) and Design for Service (DFS)

#### How DFA and DFS were implemented?

- The DFX design team included representatives from procurement, manufacturing engineering, manufacturing quality, customer service, process engineering, new product engineering, supplier quality engineering and logistics. Membership from a wide range of expertise promotes early design definition and ensures manufacturability up front in the product development cycle.
- Use of metrics - DFX metrics at Dell measure throughput, time and cost, and they are defined and implemented through several tools.

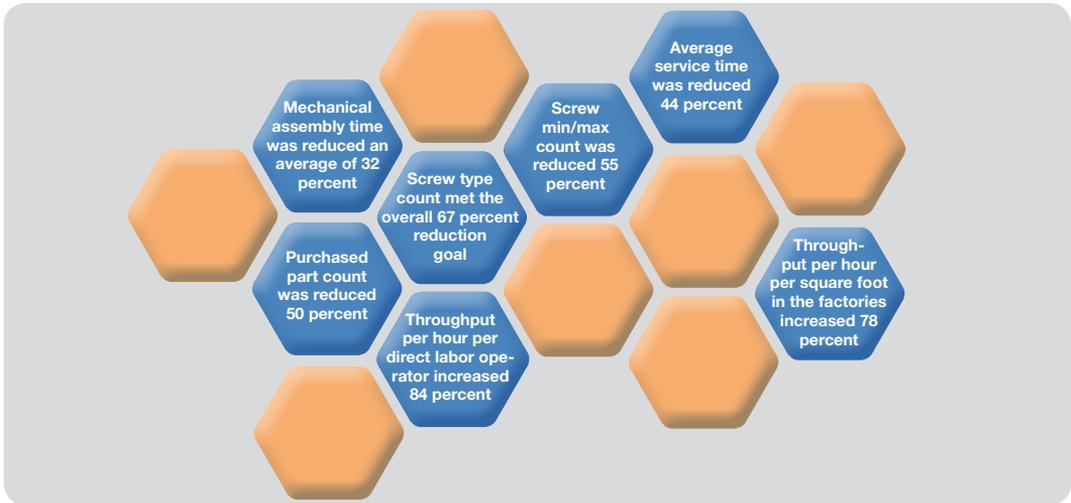
- DFA software enables engineering design teams to evaluate the functional purposes of each assembly component in a conceptual design, DFS software focuses on the disassembly sequence required to service components in the design assembly.

#### Examples of design improvements

- A hard drive bracket that rotates out of the chassis for drive assembly
- A patented hinge-lock mechanism on the stand for the power supply, which allows a supplier to install the power supply ahead of time → **Dell's assembly time cut by nearly 40 percent**
- A patented hook-and-lock retention system for the mother board, which requires only one fastener, **a vast improvement over most competitors' designs**
- A tool-less cover that provided the greatest reductions in disassembly and reassembly times – the cover rotates up and allows a customer a top-down look into the chassis within ten seconds, without his needing to use a screw driver or any other tools  
→ **A dramatic reduction of MTTR**



**Bottom line results**



**The benefits to the enterprise of DFX deployment**

**For the customers:**

- ✓ Creates a sustainable competitive edge
- ✓ Improves customer satisfaction
- ✓ Adds a marketing tool to promote sales
- ✓ Aids environmental protection



**For the enterprise:**

- ✓ Increases profitability
- ✓ Improves product quality and reliability
- ✓ Strengthens the corporate culture
- ✓ Improves collaboration and knowledge retention
- ✓ Improves the work interfaces between Development, Operations and Service

**Summary**

Despite growing pressure on companies to deliver products that are not fully mature, we should bear in mind that being first out with a product that suffers from numerous teething problems is not always profitable. High operating costs can soon outweigh any competitive edge gained. DFX is therefore becoming an essential part of the development process in stable and mature enterprises.

In order to implement DFX, attention must be paid to the following issues:

1. Management commitment
2. Change management processes throughout all the layers of the enterprise

It is important to remember that the process is lengthy because it extends across the enterprise, affecting most disciplines in it, and because it takes time for DFX to be imprinted in the enterprise DNA.

However, once this happens, the enterprise and its products work at a different level of maturity, ensuring maximized business profits.

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