Selecting Design for Six Sigma Projects

by Douglas P. Mader

Every organization maintains and constantly changes its portfolio of existing and future development projects. Portfolio management is about allocating resources within the organization to minimize risk and meet strategic goals. The three main goals of portfolio management are:

1. **Maximize value:** allocate resources to maximize the value of the portfolio in terms of some financial metrics, such as long-term profitability or return on investment (ROI).
2. **Balance:** diversify and create a mix of projects by considering project duration, development and commercialization risks, market mixes, technologies and project types.
3. **Strategic direction:** align the portfolio around a technology or market central to the organization's strategic plan.

> Determine the impact of DFSS on a project in an organization's portfolio of products or services.

Some common development activities to support these goals include cost reduction, process improvement, customer oriented product or service enhancements, new products or services created along existing technology lines and new platforms or services based on fundamentally new technologies.

There are several problems that may arise if the portfolio management process is ineffective. The organization may:

- Be reluctant to kill development activities for ongoing projects.
- Lack focus due to too many projects.
- Suffer from poor profitability due to too many low risk projects or too many high risk projects.
- Not be able to properly pene-

The 12-Step Method

DFSS project selection is built on the following 12-step method:

1. Understand the organization's strategic plan.
2. Make a list of the current and future design projects under consideration.
3. Estimate the net present value, development cost, commercialization cost, probability of technical success (standard), probability of technical success (DFSS) and probability of commercialization success for each project. Involve the appropriate finance, R&D and operations managers.
4. Rank the projects based on the change in expected commercial value (∆ECV).
5. Meet with all stakeholders to discuss the results of the ranking process. Perform a sanity check and rerank the projects.
6. Based on the final ∆ECV results, choose the projects that are the best candidates for DFSS implementation based on value to the portfolio or other qualitative criteria.

At the core team level, the steps to identify engineering activities for DFSS application are:

7. Understand the ∆ECV method and the results from the portfolio analysis.
8. Make a list of all engineering activities that must be done before the product development project can be completed.
9. If it hasn't been done already, estimate the probability of technical success for the normal development process, the probability of success for the DFSS process, the development time, the available resources and the cost for each activity in the overall schedule.
10. Rank all engineering activities according to the difference in the probability of technical success versus the cost of the effort.
11. Meet with all stakeholders to discuss the results of the ranking process. Perform a sanity check and rerank the activities.
12. Based on the final probability estimates, costs and other resource constraints, choose the engineering activities that will contribute most to the overall probability of technical success for the development project.

trate the market due to poor linkage between development and market research.

An effective product portfolio management process relies on:

- **The strategic plan:** It is the basis for the selection of new projects.
- **Senior management:** The driver of strategy, it should therefore be closely involved in new project selection decisions.
- **Project selection methods:** They mesh with the decision framework of the business, focus on the ever changing market, are used often and accommodate decision making at different levels in the organization.

An effective product portfolio management process constantly revises and updates the list of new development projects based on market changes, competitive threats, customer wants and needs, and strategic goals. New projects are selected, prioritized, accelerated, killed or deprioritized, and resources are constantly allocated and reallocated to adapt to uncertain and changing information.

The main goal of project selection for design for Six Sigma (DFSS) is to determine which development projects can benefit the most with regard to the value of the portfolio. To choose the right DFSS projects, you must first understand how projects are chosen within the portfolio management framework.

TABLE 1 **Matrix of Probabilities for Commercial Success**

Newness	Organization's competitive advantage: Low: CBR < 1	Medium: CBR = 1	High: 1 < CBR < 3	Very high: CBR > 3
Current product or service.	0.50	0.65	0.80	0.95
Significant enhancement to a current product or service.	0.35	0.50	0.65	0.80
New to organization.	0.20	0.35	0.50	0.65
New to market.	0.10	0.20	0.35	0.50

CBR = cost-benefit ratio

TABLE 2 **Matrix of Probabilities for Technical Success**

Ability to deliver (manufacturing or service operations)	Ability to develop product or service: Very low	Low	Medium	High	Very high
Very high: solution already exists and is viable.	0.50	0.65	0.80	0.90	0.95
High: solution has been tested and appears viable.	0.35	0.50	0.65	0.80	0.90
Medium: solution has not been tested but is believed to be feasible.	0.20	0.35	0.50	0.65	0.80
Low: solution is not yet known but is believed to be feasible.	0.10	0.20	0.35	0.50	0.65
Very low: solution is not yet known and its feasiblity is unknown.	0.05	0.10	0.20	0.35	0.50

Measure the Portfolio's Value

Let us examine the most common of the three main goals of portfolio management—maximizing the portfolio's value. Though several techniques are used to analyze the value of a portfolio, including classical scoring and sorting models, mapping approaches, bubble diagrams and mathematical programming, I will focus on a few simple financial methods.

A classical valuation technique is known as the adjusted net present value (NPV_A) method. The NPV_A method is used to prioritize new development opportunities for both ongoing and future projects. It estimates the value of a project by subtracting the development (D) and commercialization (C) costs from the NPV of all future cash flows in present value dollars:

$$\$NPV_A = \$NPV - (\$D + \$C)$$

The problem with this approach is that the estimated value for a particular project in the portfolio does not reflect the risks associated with development and commercialization. A product may be difficult to design or manufacture, or the company might not be confident the product will be well received in the marketplace.

One method that includes both development and commercialization risks is known as the expected commercial value (ECV) method. The ECV method seeks to maximize the value or commercial worth of the portfolio subject to budget constraints:

$$\$ECV = [(\$NPV \times P_{cs} - \$C) \times P_{ts} - \$D],$$

where

- \$ECV = expected commercial value of a project.
- \$NPV = net present value of the project's future cash flows.
- P_{cs} = probability of commercial success.
- \$C = commercialization or launch costs.
- P_{ts} = probability of technical success.
- \$D = development costs remaining in the project.

TABLE 3 **Portfolio Analysis Example**

Project name	NPV	C	P_{cs}	P_{ts0}	P_{ts1}	D_0	D_1	Adjusted NPV	ECV_0	ECV_1	ΔECV
Darth	$30.0	$5.0	0.50	0.80	0.85	$3.0	$3.5	$22.0	$5.0	$5.0	$0.0
Luke	$42.0	$2.0	0.70	0.70	0.90	$1.0	$2.0	$39.0	$18.2	$22.7	$4.5
Leia	$50.0	$1.0	0.60	0.85	0.85	$4.0	$4.3	$45.0	$20.7	$20.4	-$0.3
Yoda	$25.0	$3.0	0.80	0.60	0.70	$3.5	$4.0	$18.5	$6.7	$7.9	$1.2
Han	$40.0	$0.5	0.70	0.50	0.75	$6.0	$7.0	$33.5	$7.8	$13.6	$5.9
Death Star	$90.0	$8.0	0.70	0.40	0.80	$10.0	$12.0	$72.0	$12.0	$32.0	$20.0
Totals	**$277.0**	**$19.5**				**$27.5**	**$32.8**	**$230.0**	**$70.3**	**$101.5**	**$31.3**

NPV = net present value.
C = commercialization or launch costs.
P_{cs} = probability of commercial success.
P_{ts0} = probability of technical success under the normal development process.
P_{ts1} = probability of technical success under the DFSS methodology.
D_0 = development costs remaining in the project assuming the normal development process.
D_1 = development costs remaining in the project under the DFSS methodology.

The ECV metric can be interpreted as a weighted stream of cash flows for a development project, discounted to the present while accounting for commercial and technical risks. The ECV model favors projects that are closer to launch, have little money left to be spent on them, have a higher likelihood of success or use less scarce resources. A potential weakness is that it uses estimates of the probabilities for technical and commercial success that may be difficult to gauge in the early stages of product or service development.

Fortunately, this weakness can be addressed through a structured method for estimating the respective probabilities. There are two ways to estimate the two probabilities used in the ECV method:

1. **Delphi method**: Individuals—usually senior technical leaders—are asked to independently and anonymously estimate the probabilities for success. The results are discussed as a group until consensus is achieved.
2. **Matrix method**: The probability of commercial success is decided based on market newness and degree of competitive advantage. The probability of technical success is based on the newness of the technology to the company in terms of the product and the process.

Both methods have strengths and weaknesses, so most organizations use a combination to increase the validity of the portfolio analysis. For example, some organizations will apply the Delphi method after using the matrix method.

The matrix in Table 1 can be used as a guide to estimate the probability for commercial success. The relevant factors are the advantage the product will have in the market relative to the competition and the newness of the product in the market. The cost-benefit ratio (CBR) is defined as the sum of D and C costs divided by the NPV of all future cash flows.

The probability of technical success is estimated based on the newness of the design and the manufacturing process or service. The matrix of probabilities for technical success is shown in Table 2.

Select the Right Projects

So how will an organization know which projects will benefit the most from the DFSS methodology? To help leadership choose the right DFSS projects, I modified the ECV metric. This modification allows organizations to estimate the incremental benefit in terms of value to the portfolio due to the application of DFSS on a particular project. I call the modified form of the ECV metric "delta ECV":

$$\Delta ECV = [(\$NPV \times P_{cs} - \$C) \times P_{ts1} - \$D_1] - [(\$NPV \times P_{cs} - \$C) \times P_{ts0} - \$D_0],$$

where

- ΔECV = change in the ECV given the application of DFSS on a development project.
- \$NPV = net present value of the project's future cash flows.
- P_{cs} = probability of commercial success.
- \$C = commercialization or launch costs.
- P_{ts1} = probability of technical success under the DFSS methodology.
- $\$D_1$ = development costs remaining in the project under the DFSS methodology.
- P_{ts0} = probability of technical success under the standard development process.
- $\$D_0$ = development costs remaining in the project assuming the standard development process.

If an organization implements DFSS but doesn't consider the voice of the customer (VOC), the ΔECV is as shown above. However, if the organization implements DFSS in conjunction with a strong VOC improvement effort, the ΔECV would see an even larger increase. The ECV metric can easily be modified to account for the incremental benefit of a focused VOC effort.

A Portfolio Example

Suppose an organization used the portfolio analysis method on several projects, and the data are shown in Table 3. If the organization forged blindly ahead without considering the D or C risks (the adjusted NPV method), it would conclude Leia and Deathstar are the two best projects to pursue based on value to the portfolio. Most organizations would give these two projects the highest priority.

If the organization factored the D and C risks into the analysis using the ECV method, then Luke and Leia would be the two highest priority projects. However, if the organization used the ΔECV method and the incremental value to the organization from DFSS was considered, then Death Star and Han might have a high priority for the investment of development resources.

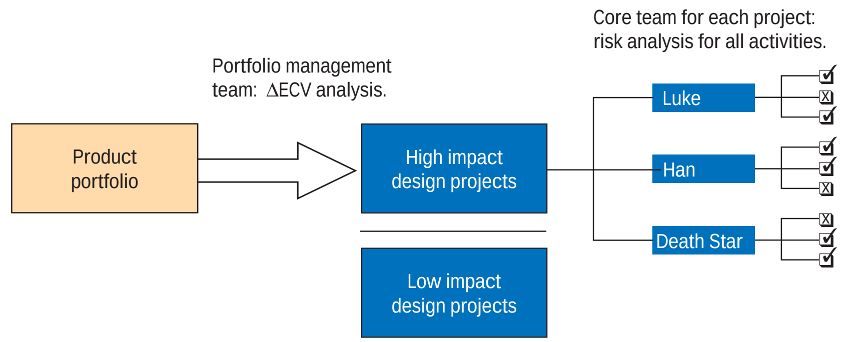
Now that the projects that would benefit the organization the most if it were to apply DFSS have been identified, senior management must determine which project activities will have the most impact on the probability of technical success. The organization should not have to invest resources to perform advanced quantitative analyses on all project activities—it should only have to invest additional resources in those activities that will influence the probability of technical success.

The leadership team should perform a high level portfolio analysis to determine which projects have the most impact on the portfolio value, thereby separating high impact projects from low impact ones (see Figure 1, p. 68). Once the high impact projects have been identified, the local R&D management team can identify those activities that will contribute most to the increased probability of technical success.

Because the probability of technical success is based on the newness of the product and the manufacturing or service and delivery process, the core team should consider both sets of activities for DFSS application. Clearly, not all activities in the schedule will benefit from DFSS. The matrix of probabilities shown in Table 2 can be used by the core team to assess each of the engineering tasks.

This DFSS project selection method should be used as a guide to the proper allocation of resources within the product development environment, but it should not be taken literally without further analysis. There will always be other intangible factors that may negate the need for or necessitate the allocation of resources on a certain set of activities.

FIGURE 1 **Project Selection Process for DFSS Projects**



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