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17.5. Examples of Continuous Innovation Process Using Design for Six Sigma

17.5.1. Example 1: A Design for Six Sigma (DMADV) Project

17.5.2. Project Background

[1]The current process to look up, retrieve, and interpret product engineering information such as component specification drawings and product structures has been in place since 1998. This system is complex and expensive to maintain. From the beginning, this process has had many shortcomings from the point of view of the primary users—the manufacturing plants. These shortcomings cost the company money in lost productivity and high system maintenance costs.

17.5.3. DMADV Process Implementation

With the long history of complaints and a limited customer base, areas of improvement were not difficult to determine. To provide focus for our team, a survey was developed and analyzed to prioritize customer groups and customer needs as well as their performance expectations for the new system. The needs became the customer CTQ items.

We worked with our customers to determine baseline capability against four criteria:

1. Accuracy of information
2. Fast retrieval of information
3. Easy retrieval of information
4. Easy-to-interpret information

From this list we constructed a quality function deployment flow-down matrix to convert the CTQs to product feature alternatives that support customer needs. The current process was mapped at high and then more detailed levels to identify areas of improvement.

A high-level design was prepared, and high-level capability was estimated. Next a more detailed design was developed, simulated, documented, and verified.

17.5.4. Results

- Accuracy level unchanged (Six Sigma capable)
- A 451 percent improvement in average print access/printout time (from 1.5 to 6 sigma)
- 100 percent improvement in virtual viewing/inquiry capability
- 300 percent improvement in drawing line weight differentiation
- Final expected savings: not insignificant

17.5.5. Project Details and Selected Slides

Problem statement: Plant quality and customer service/technical support personnel find that our current system to find and view product component and assembly information is cumbersome to access, interpret, and maintain.

Project definition: The purpose is to provide faster access to product engineering information in a consolidated format using a single user-friendly interface.

Mission statement: The project team will develop a user interface and training system to provide faster single-point access for plant quality managers, engineering, customer service, and technical support to product structures and related component and assembly specifications by July 2004.

The slides shown in Figs. 17.3 through 17.20 highlight the project for each phase: define, measure, analyze, design, and verify.

Figure 17.3 *SIPOC (high-level process map).*

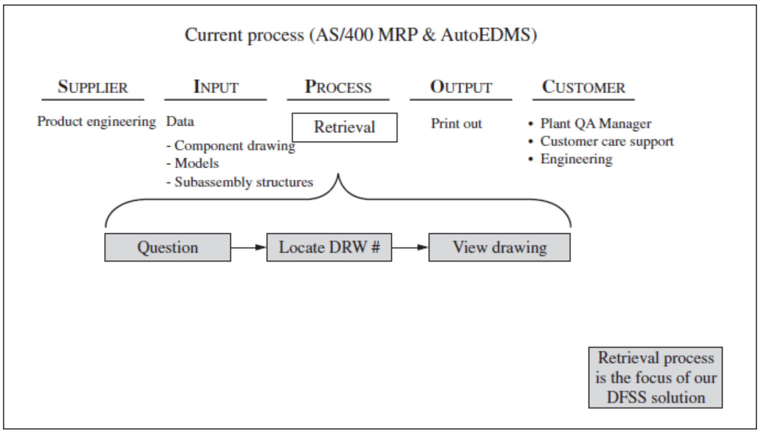


Figure 17.4 *Pareto of customer prioritization.*

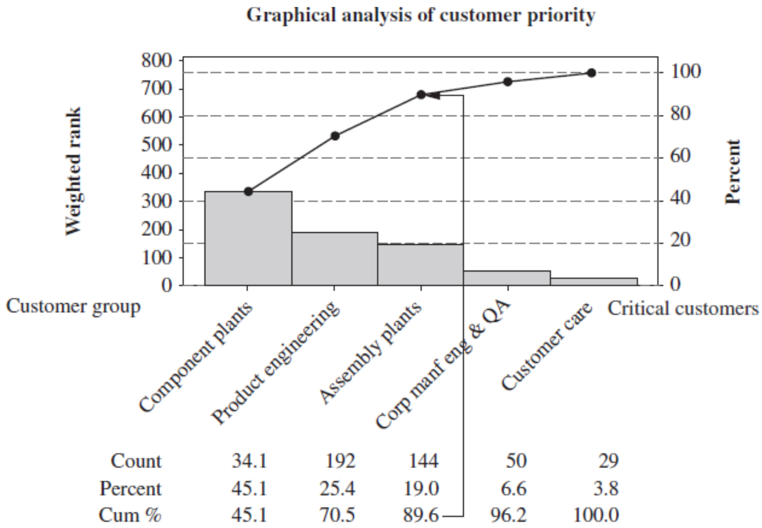


Figure 17.5 *Flow-down customer versus customer needs.*

	Customer weighting	Customer needs (based on survey results)	Accuracy of information	Speed to retrieve	Ease of retrevial	Format
		Need weighting	592	343	275	260
Prioritized customers (based on # users in group & frequency of need)		Association table customer Wt × Need Wt.				
Component plant	341		201,872	116,963	93,775	88,660
Product engineering	192		113,664	65,856	52,800	49,920
Assembly plant	144		85,248	49,392	39,600	37,440
		Totals:	400,784	232,211	186,175	176,020

Figure 17.6 *The vital few CTQs.*

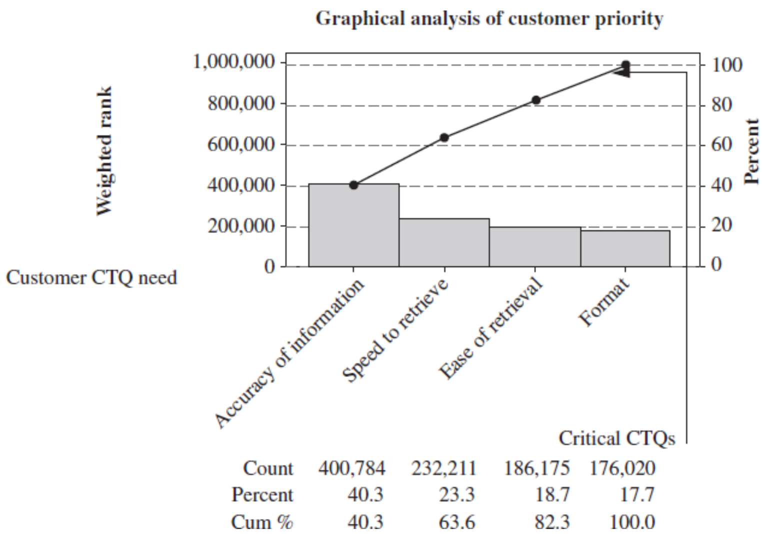


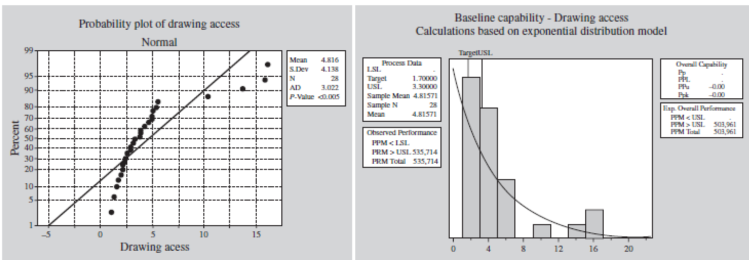
Figure 17.7 *Translation of customer needs into measurable CTQs.*

Need/ Expectation	Priority	Characteristic	Measure/ Sensor	Target	Upper Specification Limit	Allowable Defect Rate
Accuracy of information	400,784	Drawing represents part number correctly	Match: Y or N/ visual	Y	Must match	3.4 DPMO
Fast retrieval of information	232,211	Time to find a component drawing and print	Time/ Stopwatch	1.7 min	+1.6 min	10,700 DPMO
Easy retrieval of information	186,175	Number of user inputs to locate a drawing	Number of inputs/visual	10	+3	3.4 DPMO
Information is easy to interpret (format)	176,020	Different line weights are apparent on drawing	Number of multiple line weights/ visual	3	+1	3.4 DPMO

Figure 17.8 *Baseline CTQ.*

Baseline CTQ Capability Analysis
Drawing Access Spec (combined data from Dim and Non-Dim Lookup)

Normality Test



Alpha: 0.05
Ho: Data are normal
Ha: Data are not normal
P-value: <0.005, therefore reject Ho.
Data are not normal
Conclusion:
Use 1 sample Wilcoxon for data statistical analysis

Conclusion:
Baseline capability based on 500,000 DPMO is 1.4 sigma

Figure 17.9 *Baseline CTQ.*

Baseline CTQ Capability Analysis
Drawing Access Spec (combined data from Dim and Non-Dim Lookup)

Customer expectations are 1.70 minutes or faster to access and print a drawing, from CTQ survey. Is the current system running at the customers' expectations? This is the primary CTQ on our design scorecard.
See Appendix A for survey data analysis.

Ho = Sample median is equal to 1.70 minutes
Ha = Sample median is not equal to 1.70 minutes
Alpha = 0.05
Wilcoxon Signed Rank Test: Drawing Access

```
Test of median = 1.700 versus median not = 1.700

                      N
                     for   Wilcoxon          Estimated
                 N   Test  Statistic     P      Median
Drawing Access  28    28       393.5  0.000      3.750
```

P-value = .000 < 0.05
Therefore reject Ho
Ha = Sample median is not equal to 1.70 minutes

Ho = Sample median is equal to 1.70 minutes
Ha = Sample median is greater than 1.70 minutes
Alpha = 0.05
Wilcoxon Signed Rank Test: Drawing Access

```
Test of median = 1.700 versus median not > 1.700

                      N
                     for   Wilcoxon          Estimated
                 N   Test  Statistic     P      Median
Drawing Access  28    28       393.5  0.000      3.750
```

P-value = .000 < 0.05
Therefore reject Ho
Ha = Sample median is greater than 1.70 minutes

Conclusion: The current system is not meeting customer expectations

Figure 17.10 *Design scorecard.*

CTQs					
Description	Spec/Target				
	LSL	USL	Current capability	High-level Capability	Feature Capability (From verification testing)
Information is accurate	0 Errors (6 Sigma)		0 Errors (6 Sigma)		
Fast retrieval	0 sec	3.3 min	4.82 min (1.4 Sigma)		
Easy retrieval (mimimal inputs)	8	12	17 (0 Sigma)		
Easy to Interpret format (number) of line weights)	2	4	1 (0 Sigma)		

Figure 17.11 *QFD flow down: CTQs versus functions.*

CTQs	Functions: Retrieve specs by part number	Drawings retrievable by latest revision	Multiple line weights on drawing high print quality	Readily accessible	Attribute information on drawing (species/color etc.)	3D representation of cabinet	Capable of storing legacy data/drawings	
Easy to interpret (format)	□ 2	⊖ 1	■ 3	⊖ 1	■ 3	□ 2	⊖ 1	13
Fast retrieval	■ 3	⊖ 1	⊖ 1	■ 3	⊖ 1	⊖ 1	□ 2	12
Minimal number of inputs from user	■ 3	■ 3	⊖ 1	⊖ 1	⊖ 1	⊖ 1	⊖ 1	11
Information is accurate	■ 3	□ 2	⊖ 1	⊖ 1	⊖ 1	⊖ 1	⊖ 1	10
	11	7	6	6	6	5	5	

KEY	
■ 3	Strong relationship
□ 2	Moderate relationship
⊖ 1	Weak relationship

Figure 17.12 *Easy to interpret function/feature diagram.*

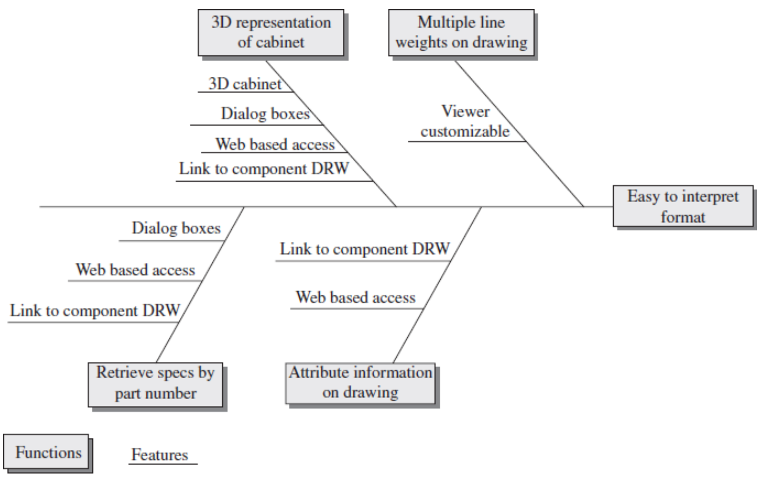


Figure 17.13 *Function/feature diagram, fast retrieval.*

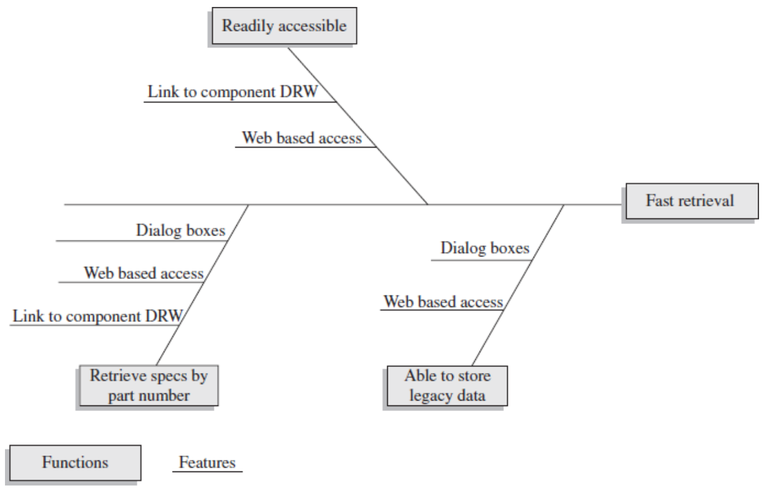


Figure 17.14 *Function/feature diagram, minimum number of user inputs.*

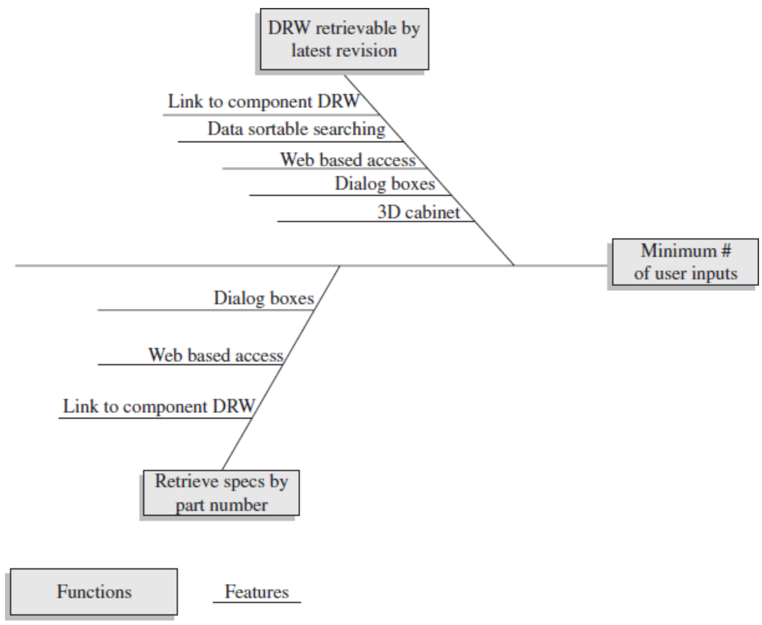


Figure 17.15 *Function/feature diagram, information accurate.*

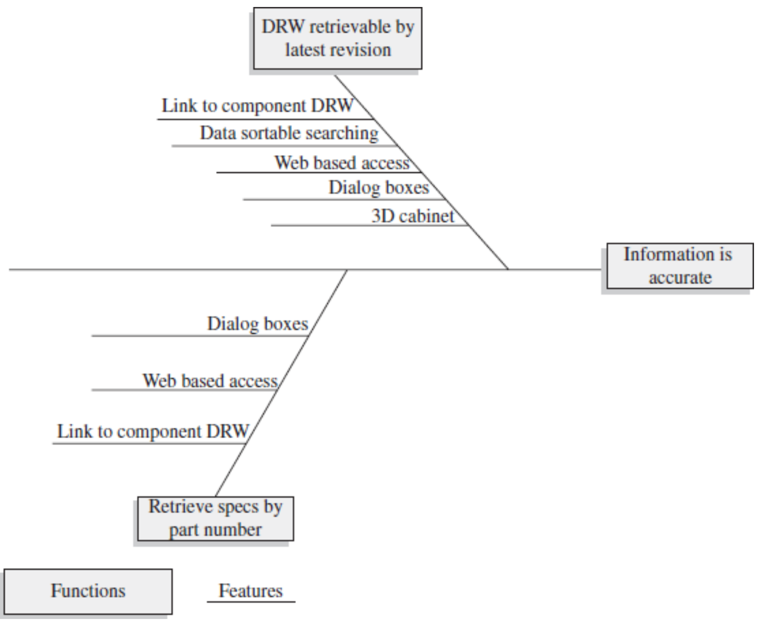


Figure 17.16 *QFD flowdown, functions versus features.*

Functions	Features: Link to component drawings	Web-based access	Dialog boxes	Virtual cab viewing	Data sortable searching	Viewer customization	
Drawings retrievable by latest revision	■ 3	□ 2	□ 2	□ 2	■ 3	⊖ 1	13
3D representation of cabinet	□ 2	□ 2	□ 2	■ 3	⊖ 1	⊖ 1	11
Readily accessible	■ 3	■ 3	⊖ 1	⊖ 1	⊖ 1	⊖ 1	10
Retrieve specs by part number	□ 2	□ 2	■ 3	⊖ 1	⊖ 1	⊖ 1	10
Attribute information on drawing (species/color etc.)	■ 3	□ 2	⊖ 1	⊖ 1	⊖ 1	⊖ 1	9
Capable of storing legacy data/drawings	⊖ 1	□ 2	□ 2	⊖ 1	⊖ 1	⊖ 1	8
Multiple line weights on drawing high print quality	⊖ 1	⊖ 1	⊖ 1	⊖ 1	⊖ 1	■ 3	8
	15	14	12	10	9	9	

KEY	
■ 3	Strong relationship
□ 2	Moderate relationship
⊖ 1	Weak relationship

Figure 17.17 *QFD flowdown, features versus alternatives.*

Features	Alternatives (X's): Use case-based training materials	JSP web page	Browser plug-in	Link from list	Java applet input box	Link from thumbnails	
Web based access	■ 3	■ 3	■ 3	■ 3	■ 3	■ 3	18
Virtual cab viewing	■ 3	□ 2	■ 3	■ 3	⊖ 1	■ 3	15
Link to component drawing	■ 3	■ 3	□ 2	■ 3	■ 3	⊖ 1	15
Dialog boxes	■ 3	■ 3	⊖ 1	⊖ 1	■ 3	⊖ 1	12
Data sortable searching	■ 3	■ 3	⊖ 1	⊖ 1	⊖ 1	⊖ 1	10
Viewer customization	■ 3	⊖ 1	■ 3	⊖ 1	⊖ 1	⊖ 1	10
	18	15	13	12	12	10	

KEY	
■ 3	Strong relationship
□ 2	Moderate relationship
⊖ 1	Weak relationship

Figure 17.18 *Verification CTQ capability analysis.*

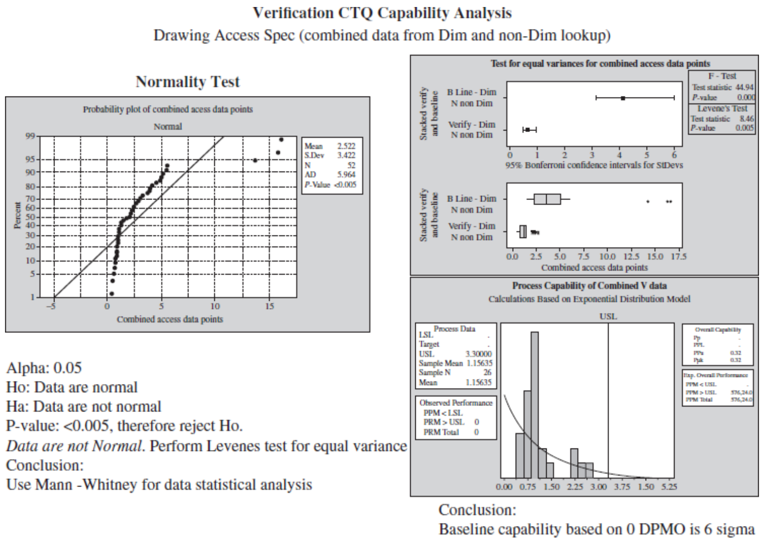


Figure 17.19 *Verification CTQ capability analysis.*

Verification CTQ Capability Analysis

Drawing Access Spec (combined data from Dim and non-Dim lookup)

Customer Expectations are 1.70 minutes or faster to access and print a drawing, from CTQ Survey. Is the new system running at the customers expectations? This is the primary CTQ on our design scorecard.

Ho = Sample median is equal to 1.70 minutes
Ha = Sample median is not equal to 1.70 minutes
Alpha = 0.05

Wilcoxon Signed Rank Test: Combined V data

```
Test of median = 1.700 versus median not = 1.700

                      N
                     for   Wilcoxon            Estimated
                 N   Test  Statistic      P       Median
Combined V data  26   26        53.5  0.002        1.033
```

P value = .002 < 0.05
Therefore reject Ho
Ha = Sample median is not equal to 1.70 minutes

Ho = Sample median is equal to 1.70 minutes
Ha = Sample median is less than 1.70 minutes
Alpha = 0.05

Wilcoxon Signed Rank Test: Combined V data

```
Test of median = 1.700 versus median < 1.700

                      N
                     for   Wilcoxon            Estimated
                 N   Test  Statistic      P       Median
Combined V data  26   26        53.5  0.001        1.033
```

P value = .001 < 0.05
Therefore reject Ho
Ha = Sample median is less than 1.70 minutes

Conclusion: DDL and the design of the user interface will meet customer expectations for drawing access time.

Figure 17.20 *Design scorecard updated and verified.*

CTQs					
Description	Spec/Target LSL	USL	Current capability	High level capability	Feature capability (from verification testing)
Information is accurate	0 Errors (6 Sigma)		0 Errors (6 Sigma)	0 Errors (6 Sigma)	0 Errors (6 Sigma)
Fast retrieval	0 sec	3.3 min	4.82 min (1.4 Sigma)	0.75 min (6 Sigma)	1.07 min (6 Sigma)
Easy retrieval (minimal inputs)	8	12	17 (0 Sigma)	10 (6 Sigma)	10 (6 Sigma)
Easy to interpret format (number of line weights)	2	4	1 (0 Sigma)	3 (6 Sigma)	3 (6 Sigma)

This example depicts well how the DFSS process takes place and can be used by the practitioner as a guide for his or her own projects.

17.5.6. Example 2: A Design for Six Sigma (DMADV) Project

This second project is an example of DFSS applied to a new product development and how that application can result in a more successful product being brought to market because it better meets customer needs. Due to the sensitive competitive nature of such a project, the example has intentionally been made generic for presentation here.

17.5.7. Project Background

The project was chartered to design a new, more competitive consumer medical device. The following sections detail the project background, important business considerations, and the customer characteristics.

17.5.8. Development Goals

Provide an improved consumer device that optimally meets feature and benefit requirements of the product line.

17.5.9. Product Description

The product is a medical device for use by patients with specific conditions that lend themselves to use of self-monitoring systems.

17.5.10. Process(es) within Scope

- Industrial design
- Packaging configuration
- Device color, texture
- Device configuration
- Device ergonomics, ease of use
- Launch schedule

17.5.11. Market Strategy

The current market for this device mirrors the market for the higher-level devices it is used with. However, only 40 to 50 percent of our users of the higher-level device report using this device's current version. Among our competition this device is a much higher source of revenue, and this would imply that they can produce it at a lower cost.

17.5.12. Financial Strategy

Of today's similar devices 98 percent go into kits. Therefore, reducing cost is important.

17.5.13. Technology Strategy

No off-the-shelf original equipment manufacturer devices provide multiple capabilities. However, the project can leverage prior development efforts to implement enhanced capabilities in this design.

17.5.14. Product Strategy

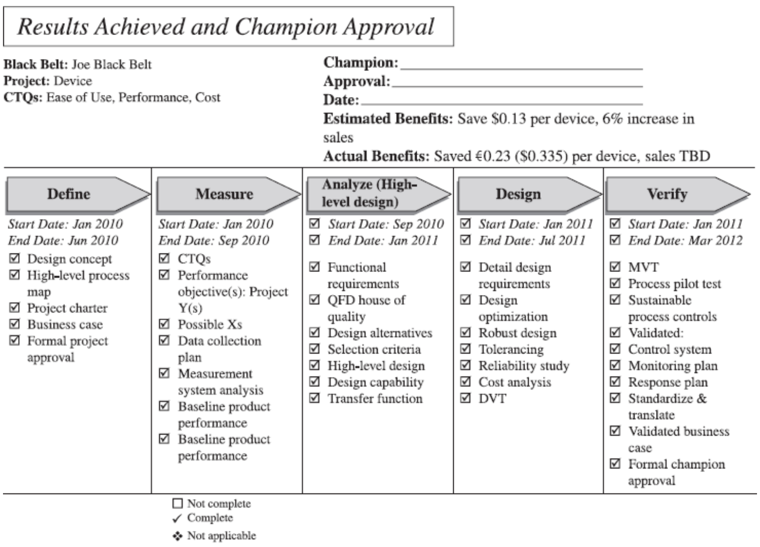
The strategy is to provide a device that maximizes customer acceptance across all major higher-level device platforms.

17.5.15. Design Project Approach

Leverage existing device development, especially internal mechanism with reduced bounce (associated with pain).

Figure 17.21 shows the process the team followed, each step completed, and the associated timing. Also, you can see the actual results of the project as measured by the marketing and financial strategies above. The project in fact exceeded the cost reduction goal of $0.13 per device with the actual reduction of $0.335 per device.

Figure 17.21 *DFSS applied to medical device design.*



It may also be noted fromFig. 17.21 that the total project took a little more than 2 years. Particularly for the application of DFSS to new product design, as in this case, it is common for DMADV projects to take a good bit longer than DMAIC projects.

[1] Adapted from the final report of a Six Sigma design project led by Dave Kinsel at a Juran Institute client; with acknowledgment of thanks.