# DFSS Road map for manufacturing stabilization in new product development

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## Abstract

Currently New product development is getting more important. As customer requirement is complicated, company should meet customer requirement exactly in short time. How well manage new product development process without failure and with lower cost? DFSS is the one of good process to get the new product stabilization. To improve process, we use road map "DMAIC". However, DFSS does not have formal process. Current DFSS roadmap is too long and complicated like "DMEDI", "DMADV", "DMADOV" or "IDOV". DFSS roadmap could be different between item and industry. So this study will show you effective but simple roadmap "OAOV" (Object -> Analyze -> Optimize -> Verify). OAOV will focus how well reduce risk after mass production.

**Key-words : (DFSS, Manufacturing, new product, 6 sigma)**

## 1. Introduction

Six sigma is good methodology to manage quality level of product. Nowadays, 6 sigma is used not only improvement of process and product, but also sales and marketing, service area. DMAIC is roadmap to improve existing process and product. But it is not suitable roadmap for innovation and invention process and new product. Moreover, business situation is getting more severe. Customer needs is changing fast and getting more complicated. Company should meet customer requirement in short time and in lower cost. However, new product and new process has risk because there is no experience data for that. So from first step, new product and process should meet six sigma level to minimize risk after launching. At that time DFSS is one of useful methodology to develop new product effectively. Most strong point of DFSS is that can define customer requirement so called "Critical To Quality"(CTQ). And every step is focusing on how to meet CTQ. However, there is no standardization roadmap. DMAIC. DMADV, IDOV(identify, design, optimized and verify)(Antony and Banuelas, 2002), DMADOV is used extensively as a DFSS roadmap. DFSS roadmap could be different between each industry and product. But current roadmap is required too long time and useless job. And they are focusing on how well find CTQ even though manufacturing is most important factor for success product in market. So in this paper, new roadmap will introduce "OAOV (Object – Analysis – Optimize – Verify). OAOV will help to simplify DFSS roadmap and to handle control plan after launching new product. Especially, OAOV is focusing on manufacturing feasibility. After mass production, manufacturing performance affect saving cost and supplying finished good. However, it is difficult to estimate what cause problem during manufacturing. So OAOV is focusing on manufacturing stabilization.

## 2. Current roadmap study.

### 2.1. DMADV roadmap



<Figure 1 : DMADV roadmap>
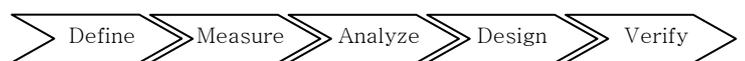
(1) Define : This phase is defined business opportunity, project scope and team charter. To decide business opportunity, SWOT, BCG Growth-Share Matrix or

GE Business Screen Matrix could be used. After decision of project scope, Gantt Chart and Pert Chart would be useful to make plan.

(2) Measure : At this phase, customer requirement analysis is most important activity which is called "CTQ" (Critical to Quality). To decide CTQ, it should be done to identify customer such as "what do they want?", "What do they choose?". You need to survey market and to gather information. As a result, we can get a list of customer requirement. We should choose important customer requirement by QFD or AHP tools or Kano in a list of customer requirement.

(3) Analyze : At this phase, we decide product design concept to meet customer requirement based on CTQ. FAST (Functional Analysis System Technique diagram) could be useful tool to divide high-level design. FAST is easy to shows that each function included which level. FBD(Functional Block Diagram) is also one of useful diagram which shows data and information flow between each function. After decide design concept of product, it is required to check reliability of product. FMEA is effective tool to find potential failure modes. Moreover, to prevent failure mode it helps making control plan and improve plan.

(4) Design : In this phase, detailed design is developed to meet CTQ. Pilot test and DOE for process control is required to set up detailed design. To develop detailed design 3 principle could be helpful - adding, reducing, contrasting. Adding principle is Value and Benefit added. Reducing is Cost and time and errors and defects. Contrasting is redesign, change[1]. One of important factor in this phase is to review manufacturing performance. DFMA(Design for Manufacturing and Assembly) could be effective tool to review Manufacturing factors. We check priority factor in manufacturing such as cycle time, cost, reliability, quality. To reduce each components and assemble correctly and no adjustments is important in DFA(Design for Assembly). DFM(Design for Manufacturing) can reduce manufacturing cost with keeping same quality level. Also in this phase, CTP(Critical to Product) should be decision by DOE(Design of Experiment) and Taguchi methods. Final step of this phase, control plan and verification step is important. To successful verification, 5W2H method could be appropriate (Why, What, Where, Who, When, How, How much.).

(5) Verify : In this phase, based on analysis phase results such as CTP, verification activity is accomplish. Pilot Test is most important activity to verify CTP. PDCA cycle could be helpful for pilot test. When Pilot monitoring, we can analyze CTP situation by SPC(Statistical process control). If there is assignable causes, we should define the reason and control plan. After finishing this activity, documentation and standard, flowchart should be set up. Finally, project could be closing. At that time each function has a meeting to discuss project performance, what should be improved.

This road map has 5 steps. This roadmap would be good to understand customer requirement through define and measure phase. Also design of product process is organized well. However, this roadmap is not enough to transfer to manufacturing.

## 2.2. DMADOV roadmap



Define → Measure → Analyze → Design → Optimize → Verify

<Figure 2 : DMADOV roadmap>

(1) Define : Project Define and scope should be done in this phase.

(2) Measure : Customer market survey is done in this phase to decide CTQ by VOC. .

(3) Analyze : From the design score card, Design concept is decided to meet customer requirement.

(4) Design : Design component is analyzed. Through FMEA, Design component is chosen.

(5) Optimize : In this phase, optimized design is decided to respond environmental condition changing. First of all, verification of design should be done. Resources should put effort on this process because of there is no experience data for new product. But if this process is skipped, it should be problem during pilot test. After verification of design, some factor should be optimized which is not suitable to meet internal – external situation.

(6) Verify : In this phase, pilot test and control plan and documentation activity should be done.

This roadmap is very detailed process. So it would be effective roadmap which new product has enough time or long term project.

## 2.3. IDOV Roadmap

<Figure 3 : IDOV Roadmap>

(1) Identify : In this phase, identifying customer requirement is key activity. So CTQ is created in this phase. It is same as "Define and Measure phase" in DMADV.

(2) Design : Analysis customer needs is done. Based on customer needs, design component is selected. Design phase in IDOV can cover Measure and Design phase of analysis customer requirement and internal situation.

(3) Optimize : At this phase, critical X's could be found through DOE. And general manufacturing and assembly specification is decided in this phase.

(4) Verity : It would be similar to verify phase with previous roadmap.

This roadmap is suitable for complicated designed product. Because manufacturing review stage is not enough. Optimize and verify stage is just to confirm product design possibility.

## 3. OAOV Roadmap


<Figure 4 : OAOV Roadmap>

3.1 Object phase

In this phase object should be decided to answer following question "What should we make?" , "What is customer requirement?". This phase is important in terms of direction project goal, scope.

(1) Decision Product Scope

To decide product scope, finding potential customer is important activity. SWOT and BCG matrix could be useful to market segment.

(2) Define CTQ

After decide product scope, Critical to Quality should be defined. At that time market survey and gathering data would be important activity in this phase.

(3) QFD

Based on CTQ, it should be defined design component to meet CTQ. QFD is most useful tool to define design component.

3.2 Analyze phase

Product design should be defined in this phase. High level design and detailed design should be decide first. And review the design could reach to project object without potential failure mode. And financial review should be done in this phase. After that, management level decision should be required to go to forward step or to kill this project.

(1) Define Design.

High level design and detailed design should be done. After developing high level design or detailed design, FMEA should be done to find potential failure mode.

(2) Check Design.

Product design should be reviewed by each function. Such as financial review is important if this product has cost competitive. Also manufacturing review is required if investment of machine is required or not. Also at this time DOE and pilot test also required to check manufacturing feasibility.

(3) Review Design

In this phase, each function management level review should be required whether this project go forward phase or not. Every function should estimate possibility to success on this project. At that time BMO Methodology (Bruce Merrifield -Ohe) should be useful[3]

3.3. Optimize Phase

Manufacturing review is main activity in this time. Design and critical factor of product should be done in Analyze phase. And critical factor and potential failure mode should be checked and reduced should be done in this phase.

(1) Qualification

In design phase, critical X's should be selected through DOE. With this process condition, qualification should be done. It is recommended 3rd time for qualification. During qualification, raw material lot deviation and each environmental test should be done. As a result process condition and environmental test has no problem.

(2) Pilot test

After confirming there is no problem between each process condition and product own design, Pilot test should be done. It is also recommended 3rd time. During pilot test, yield and estimated factory cost should be done. In this phase, customer evaluation should be done at that same time.

(3) Optimization

During qualification and pilot test, if potential problem is found process or product should be optimized. Also there would be complaint from

customer side. So each function should work together to solve any problem.

3.4. Verify phase.

(1) Standardization and Documentation

Every process should be standardization. And it should be written in Documentation. Training operator is also required.

(2) Transfer

Each function has review this project to decide this project can be finished.

## 4. Conclusion

This study shows new roadmap "OAOV" which is focusing on manufacturing during new product development. This study can help a company which has complicated manufacturing process to reduce risk of mass production. Also, OAOV will help to perform DFSS in short time. However, this paper is focusing on new product which transfers from laboratory to manufacturing. This study is not suitable in service area. With empirical research, effectiveness should be confirmed.

**REFERENCE**

[1] 노재범 외, service innovation engine six sigma, 삼성경제연구소, 2005.

[2] 이순산, 6 sigma DFSS guide book, 이레테크, 2004

[3] D. Bruce Merrifield, "How to select successful R&D projects", Management Review, pp25~39, Dec. 1978.

[4] J.A. Johnson and H.Gitlow, "Designing New Housing at the University of Miami: A "Six Sigma" © DMADV/DFSS Case Study", Qualify Engineering, Vol. 18, pp. 299-323, 2006.

[5] Kai Yang, Design for Six Sigma for Service, McGraw-Hill, 2005.

[6] Ricardo Banueals, "Six sigma or design for six sigma?", The TQM Magazine, Vol 16, No.4, pp.250-263, 2004.