A Case Study of Six Sigma R&D Improvement Projects: Design Optimization of Inner Shield Omega CPT

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Abstract

This is an R&D project on design optimization of the inner shield of the Omega color picture tube at Samsung SDI in Korea. This was an R&D project which basically used the IDOV (Identify, Design, Optimize, Validate) process for Six Sigma implementation. Most Six Sgima projects use the process of DMAIC (Define, Measure, Analyze, Improve, Control). However, this project introduces a new cycle, RDIDOV (Recognize, Define, and IDOV). Here CPT means Color Picture Tube. Samsung SDI is one of the two companies which began Six Sigma in Korea. This case study shows a good example how an R&D Six Sigma project can be usefully employed in manufacturing companies using a new process cycle.

Key Words: Six Sigma, RDIDOV

1. Introduction

Samsung SDI is one of the two initiators of Six Sigma in Korea. When the company applied for a National Six Sigma Quality Award In 2000, it submitted a book entitled "Six Sigma case studies for quality innovation." This book contains the 10 most remarkable

This work was partially supported by Korean Research Foundation Grant (KRF-2003-041-C00056).

results obtained by Six Sigma project teams. One DFSS (R&D Six Sigma) case study is presented here. The team consisted of 8 persons (one is a champion, and the other 7 members are all BBs). The duration of this study was from January to June of 2000. The team basically used the IDOV (Identify, Design, Optimize, Validate) process. However, it added R-D(Recognize and Define) before IDOV, hence the process of team activities is R-D-I-D-O-V. <Table 1> shows the project implementation steps used by this team.

In <Table 1> we use the following abbreviations. The detailed contents at each step are explained below.

Abreviation: CPM = Critical parameter method, QFD = quality function deployment
CFR = Critical functional responses, FMEA = failure mode and effect analysis
MSA = measurement system analysis, DOE = design of experiments
ANOVA = analysis of variance, DFM = design for manufacturability

Table 1. Project implementation steps of a DFSS team

DFSS steps	Detailed steps	Tools used	Design review for product development
R(Recognize)	• Analysis of CPTmarket trends • Preparation ofcustomer value map	• Customer review • Business planning	
D(Define)	• Selection of OmegaCPT CFR • Theme selection ofCPM flow-down	• QFD, CPM • Concept engineering	DR1
I(Identify)	• Selection of project CFR • Failure analysis • Measurement analysis	• FMEA • MSA • Benchmarking &gap analysis	
D(Design)	• List of all input variables • Design of basic shapeand Decision of prototype • Tolerance analysis foryield improvement	• Cause & effect matrix • Simulation,Capability study • Tolerance design	DR2
O(Optimize)	• Determination of big Xswhich influence Y • Determination of optimallevels of big Xs • Quality check throughpilot study • Completion of paper design	• DOE & ANOVA • Robust design • DFM	DR3
V(Validate)	• Verification for massproduction • Analysis of processcapability • Determination of finalproduct quality	• Process mapping • Capability study • Reliability study	DR4

2. Recognize

The current management strategy of Samsung SDI is to have four number 1 products in the world. In order to have the world's best CRT, customer needs must be met. The major customer demands for a new CRT are as follows.

- slim (short back length)
- larger scale and really flat
- high-quality screen performance
- HD resolution
- long life and quick start

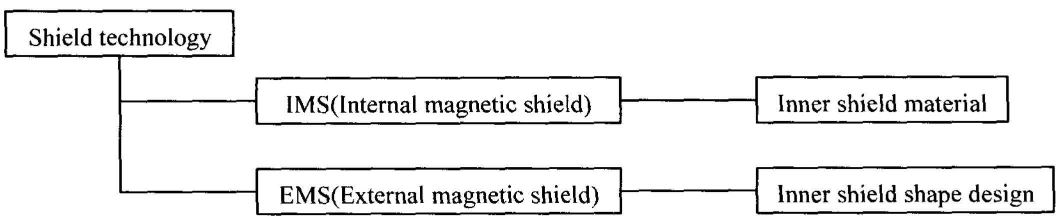
To meet the above customer demands, it was necessary to develop a new product, called Omega CPT.

3. Define

The key problems to be solved for the above demands were as follows.

- Slim: The short length increases deflection angle and decreases I/S (inner shield) height. The Omega CPT is sensitive to external magnetic field. Hence, the key issue is to minimize the influence of the external magnetic field.
- High resolution: High resolution decreases spaces between stripes, which makes the pitch small. The small pitch makes the landing shift of the electron beams large. Hence, the key issue is to minimize the landing shift.

The technology relating to magnetic shields for solving the above is to consider the design of the inner shield material and inner shield shape as shown below.



4. Identify

In order to determine the critical parameters, the following critical parameter method(CPM) was used, and the inner shield was identified as the major critical parameter.

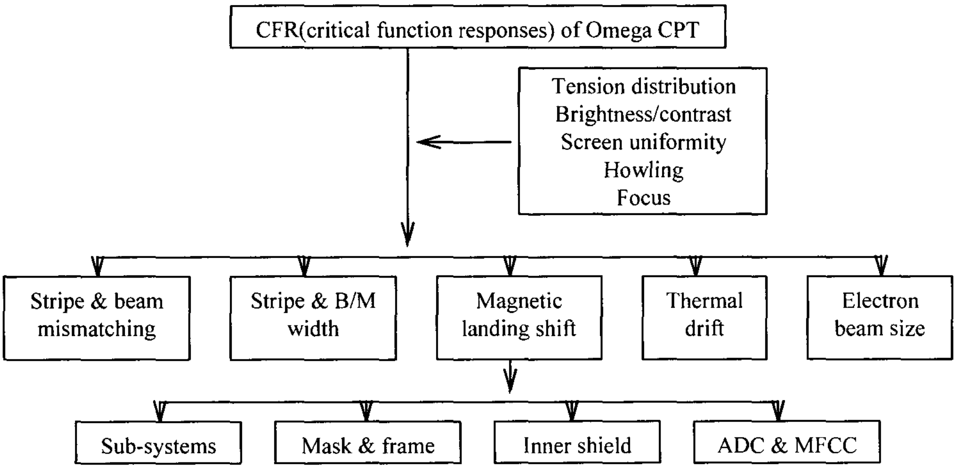


Figure 1. Critical parameter identification

The magnetic landing shift had to be minimized. However, the landing shift was directly related to CFRs of the design of the inner shield. The goals for the magnetic landing shift were as follows.

	Magnetic shift	Yield	Sigma level
current level	C	C	1.25
first goal	B	B	4.38
final goal	A	A	6.00

5. Design

What are the key parameters of the inner shield for minimizing the magnetic landing shift?

To determine the parameters, the flowchart of the design process <Figure 2> for the inner shield was sketched.

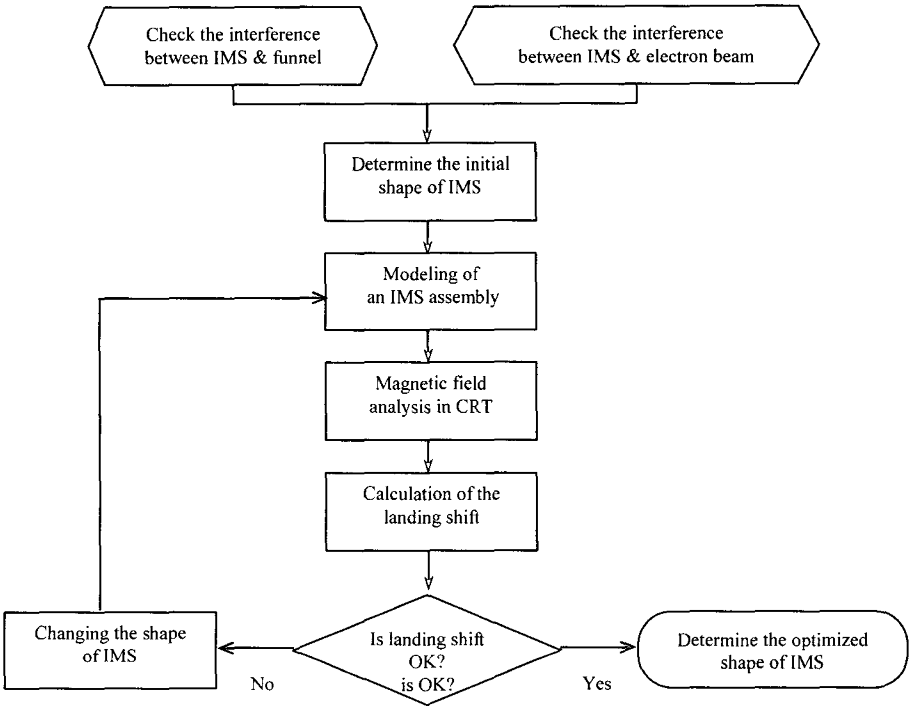


Figure 2. Design process of inner shield

The design parameters of the inner shield are listed as follows according to sub-system level CFRs, shape, and material.

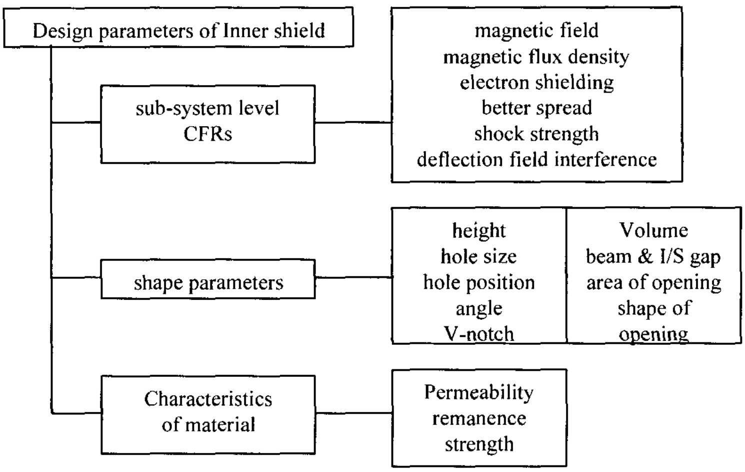


Figure 3. Design parameters

A cause-and-effect matrix and an engineering simulation study were made to select the critical parameters. As a results, four parameters (material, hole size, height, V-notch) were selected.

6. Optimize

To find the optimal levels of the four key parameters selected, a design of experiments (DOE) was run. The levels investigated were as follows. The levels used originally were IV(old) for material, medium for hole size, A mm for height, and B mm for V-notch.

Factors	number of levels	level values
Material	2	IV(old), POS(new)
Hole size	3	large, medium, small
Height	3	A mm, B mm
V-notch	3	A mm, B mm, C mm

The total number of treatment(factor) combinations could be as many as 2×3×3×3 = 54, which is too many in practice. Hence, $L_{18}(2^1 \times 3^7)$, which is an orthogonal array was used and a total of 18 treatment combinations were run. The experimental results and the analysis are not given here. However, the optimal levels were found to be POS(new) for material, small for hole size, A mm for height, and C mm for V-notch.

7. Validate

A confirmation test was attempted to validate the results of DOE and the optimality was confirmed. Finally, a cost/benefit analysis was made and the manufacturability and productivity were studied to prove all were satisfactory. Thus, the first goal of this project (magnetic shift B, yield B, and Sigma level 4.38) was achieved. From this, the cost reduction was estimated to be $0.2/each, which is equivalent to $0.25 million per year.

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