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A NEW MANAGEMENT PROCESS TO ANALYSE THE AUTOMOTIVE COMPONENTS' COMPLAINTS THROUGH DMADV

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ABSTRACT

Design For Six Sigma (DFSS) is a methodology able to join innovative thought to several analytic tools in order to design products, services and processes. The target of this methodology consists of reducing development time and cycle time through combined efforts of many resources and through process design within specification target and in compliance with excellence. Usually design and development are independent activities on other internal functions of the same organization, but this doesn't occur with a right approach such as DFSS. Exactly a work group is made up of interdisciplinary experts: know-how holder, statistical method experts and prospective customer especially internal one; all this is useful to tackle the problem with an overall view. An important aspect of DFSS is to transform the reactive design approach in a more proactive approach. In particular this requires: to understand what the customer wants up front, to control the critical design parameters as part of the analysis, to calculate the design capability, to measure and to test in quality rather than to predict and design in quality.

The main reason DFSS helps start with inherently more robust products or processes is the focus on impact of uncertainties as part of the design process. DFSS improves the design process by adding more discipline to the up front modelling and analysis in order to obtain a correct new products or processes introduction; it helps to do this by means of driving for transfer function between CTQs and Design Parameters.

Keywords: DFSS, DMADV, Diagnosis, Process Simulation

1 INTRODUCTION

The DFSS methodology follows two kinds of approach: the project of new processes and the project of new products. The first one is called DMADV (Define, Measure, Analyze, Design, Verify), while the second one IDOV (Identify, Design, Optimize, Verify/Validate).

This paper describes the activity of a new management process to analyse the FIAT components' complaints through DMADV approach in automotive field.

Define step establishes the Project chart and the high-level targets as well as to have always a reference mark in the future decisions; at this point identifying risk factors and planning of activities is a fundamental in order to the success of the project and the integration of all participants. The management of the team members and of the relative ideas is necessary to study the critical problems with the same business strategy.

In the Measure step there is a deep customer's analysis to understand their needs and to know into details the Voice Of Customer (VOC); but it's important to consider the most relevant customer to the design it has to be realized. Quality Functional Deployment (QFD) is a tool very useful to quantify and correlate VOC vs Critical To Quality (CTQ) characteristics to determine main and critical points of the project.

The Analyze step concerns the development of detailed-level design in order to fulfil the customer requirements gaining as more business benefits as possible in compliance with the Environment, Health and Safety constraints. The most critical process's functions are tested through three diagram and QFD's matrix.

In the Design step the process, product or service is defined into details in order to deliver an excellent and functional product and to meet the customer needs.

The Verify step is the last but not the least phase of the project; in fact it has to assure the CTQs to be able to achieve the quality range, respecting reliability parameters and budget constraints. Therefore the team members and the process owner implement the optimal process in full-size scale. The complete

documentation, the results and the developed studies has to be gathered because they are a useful information for a new generation of design of processes, products or services.
One of the most useful tools expressly thought for this project is a checklist of the design steps (Fig. 1). This one deals with all the phases of the DFSS method, necessary to manage the project activities.

Define Opportunity				COMMENTI	
Business strategy					DEFINE
Preliminary Customer opportunity					
Business Case					
Preliminary Targets/Goals					
High-level Concept					
Project scoping					
Project Boundaries					
Multi-Generation Plan					
Project Team					
Project risk					
Project Management					
Project Timeline					
Role&Responsabilities Identified					
Project charter					
Baseline (Redesign)					
Current Process Mapped					
Current CTQ Measured					
Current CTQ Gaps					
Customer Needs					
Customer Identified					
Customer Needs					MEASURE
VOC Prioritization					
VOC Benchmarking					
CTQ Specified					
CTQ Determined					
CTQ Benchmarking					
QFD 1					
CTQ Prioritization					
CTQ Scorecard Part 1					
Risks Assessed					
Design Concept					ANALYZE
Fuction Determined					
Function / Process Map					
Alternative Concept Developed					
Best Fit Concept Picked					
High Level Design					
QFD 2					
Function Prioritization					
Risks Assessed					
Detailed Design					DESIGN
Detailed Process Map					
Detailed Design Elements					
QFD 3					
Detailed Design Capability					
Simulation					
Capability Analysis					
FMEA Conducted					
Sigmas predicted					
CTQ Scorecard Part 2					
Control/Verication Plan					
Gap Analysis					
Results/ Modify Design					
Verification&Validation Test					VERIFY
Pilot rollout Test					
Pilot Performance Measures					
Pilot Report Prepared					
Performance Gaps Identified					
Redesign as Necessary					
Full-Scale Implementation					
Implementation Plan Developed					
Implementation Plan Executed					
Post-implementation review					
Project Closure					
Lessons Learned					
Recognition					
Multi-Generation Plan Update					
Transition to Process Owner					

Fig. 1 – Check list of the design steps

2 CASE STUDY

FIAT AUTO, for a particular business choice, has selected, as research partner, the ELASIS Experimental Centre, that has realized a particular “Complaints Macro-Process” (Fig. 2), which is able to manage all problems in relation with faulty spare parts of FIAT Group. ELASIS has to realize a diagnostic activity working on an automotive components’ sample from substitutions during warranty period. It’s important to identify responsibility about components’ failures in order to proceed in recourse on either suppliers or assistance retails: so FIAT has improved its technical knowledge. Project results are fundamental to define the production and projectual processes of the Group in a long period. The main processes activity are: Data Management, Components Management, Macro-planning, Diagnosis, Product Improvement, Know-how Development and Consolidation.

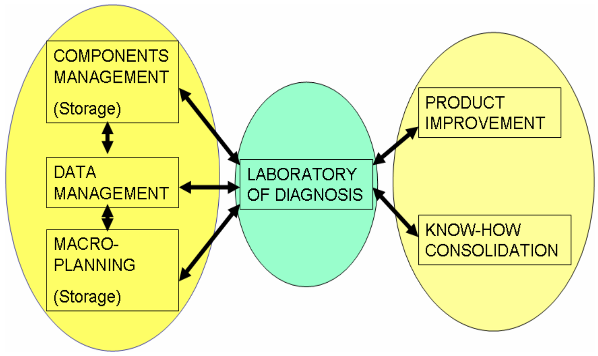

Fig. 2 – Complaints Macro-Process

Diagnosis activity analysis can be divided in: Recourse activity that is used to proceed against suppliers or Assistance retails protesting used against eventual failures; Know-how enforcing activity will help to update technical knowledge in relation with building and assembling. This Data Management process has to give complete information about every anomaly, a distribution of faults and a flaws classification concerning with defect typology. Macro-planning is useful as a resource in the activity annual allocation planning and is necessary for test planning updating. Components Management supplies to material demand from ELASIS Centre and internal components handling.
The study was focused on the last process in compliance with DFSS approach. At the beginning it’s important to map the new activity completely and then to set the scope of small problems to understand the link between real input and project variables output. Component Management process is fundamental also for the other processes, in fact only with a good management of components and their handling we can perform correctly following activities. Just this process plays an important role in the connection of various diagnostic cells both internal and external. DFSS approach is correct also if we consider a transactional process because it’s the right direction to limit possible variability sources.
The process is characterized by three main functions: coming material management, inner handling centre, shipment toward outside.

3 DMADV APPROACH

The main goal to obtain customer satisfaction is the elimination of non-conformity processes before they show themselves reducing their variability as more as possible. In this situation customer is not buyer (someone that receives end-product) but one of all company department; we speak about internal customer that is equally important external to gain an excellent process.

DEFINE - The first step for a complete design development of all activities is the project charter, a process map, a risk evaluation and an objectives planning. Project charter must be always updated and has to contain a Multi-generation plan in which it is possible to find more different design phases scheduled for time priority. It's necessary to split the problem for the presence of more variables and for the possibility to gain more results in a big scale; so we prefer determine two or more project generations and for each one specify Vision, Process and needed Technology. SIPOC (Supplier-Input-Process-Output-Customer) is an actual communication tool and is a good baseline for team work. Non-manufacturing processes, like this one, have less evident functions than the others: for this reason it's important to identify hidden activities through process map. Risk evaluation is the tool we have used to explain problems in relation with "Component Management" and to understand which nets are reached. Project leader and team have to know inner risks of the design and how to reduce or eliminate the dangerous one. If we represent the risk weight with the traffic-lights colours (Fig. 3), the yellow and red risks have to be mitigated with corrective actions.

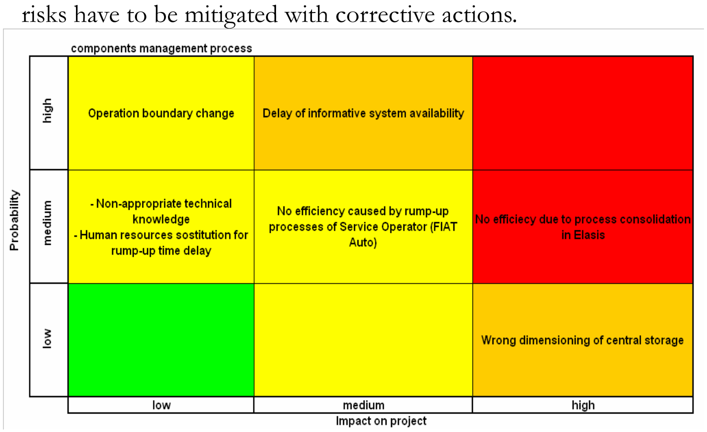

Fig. 3 – Risk Evaluation table

Before proceeding beyond it is necessary to develop a table of risk-mitigation in which we can find useful information such as: what's to be done, and when to implement the solution.

MEASURE - At this phase we have to identify VOC, in order to determine and analyze CTQs, to develop QFD1 matrix and to fill in Scorecard the obtained information.
We have to consider each VOC as a measurable indicator (CTQ). Therefore to check the CTQs (Fig. 4) means to monitor the customer satisfaction in comparison with a target value.

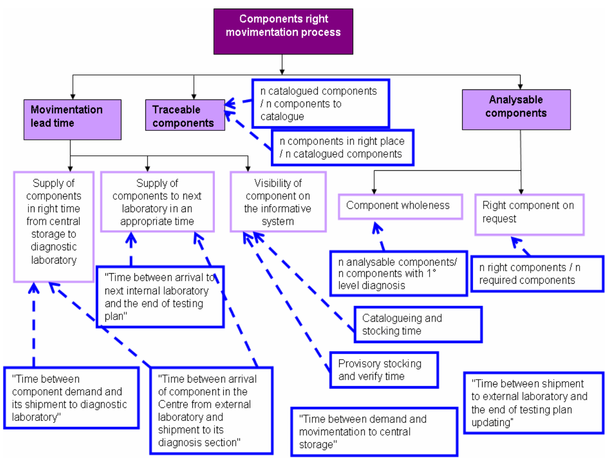

Fig. 4 - CTQ diagram

After the collection of the needed information it is possible to realize the QFD1 and to obtain some very important CTQs, such as:

- n° of analysable components/n° of components with 1° level diagnosis;
- n° of right components/n° of required components;
- time between demand and handling to central storage;
- time between coming of component in the Centre from external laboratory and shipment to its diagnosis section;
- n° of components in the right place/n° of catalogued components.

Finally it is realized a Scorecard in order to supply a first evaluation of process reliability to guide the design in the right direction in accordance with Quality Assurance. Scorecard is a table in which is possible to compare the gap between forecast values and those really achieved. So it's possible to improve the system before the end of complete design. Scorecard helps also to evaluate the margin of improvement for each CTQ so that it's easy to identify the engineering bottlenecks of project.
From previous considerations it is useful to point out that cataloguing and traceability are main topics that is important to guarantee in order to have an excellent process.

ANALYZE - When process begins to be based on the characteristics underlined in previous steps, the most important functions have to be determined. The goal is to build a function flowchart, completing QFD2 and identifying projectual parameters influencing the process. After the description of all functions that constitute the process, we can proceed filling QFD2 following the priority of the relative customer needs. The aim is to prove if and how implementing a function so that it is possible to reach CTQs target value. In this case study the most important functions are: handling, stocking and assigning priority of components. To carry out these operations we have to use printers, bar-code readers and RFID system.
We realized a fishbone diagram. Usually, with this tool, the causes that could influence design CTQs are underlined, classifying the causes in six typologies (Man, Material, Machine, Environment, Measure and Methods).
Since we start (from "a white piece of paper"), the fishbone diagram is to be intended not in the classic form, but as a way to help the team to focus on projectual parameters determination. More detailed are the diagrams, better is the support for the team members in problem solving.

DESIGN - This is the one of the most important step because at this point previous analyses join. We proceed filling QFD3 in order to assign the importance level to the elements previously identified; then, concerning with the obtained results, we define the structure. Finally we build a model of the process as closer as possible to reality, to have the possibility to test its experimental behavior. After realizing QFD3 we have to take account of the following parameters:

- equipments for components handling;
- equipments for temporary stocking/ handling;
- inventory;
- time checking;
- training;
- practices for temporary stocking/ handling;
- practices for critical samples handling;
- analysis of the causes of eventual wrong shipment.

At this point, as the examined process is a not existing one, it is required a model able to simulate (the Simulation Model by ARENA 4.0 - Fig. 5) the operating of whole system within the activities of diagnosis sections, to understand how to use the best resources. This model has also to locate the correct dimension of general storage and the crossing time of samples.
The examined process considers also the five diagnosis sections and the chemical - metrological department. This is the point of the process which we have to focus on. Another consideration is about timing of incoming samples, which is about , on regime conditions, of 6000 samples/year.
Obviously the flux will be not continuous; so we have to establish how many units come in a day, an incoming frequency approximation, with a triangular distribution. Indeed all the supposed lead times, basing on experts' knowledge, have a triangular distribution: it needs only an optimistic evaluation, a pessimistic one and the most probable value. The scheme is "one piece flow" that will be used for all process phases. When we entry for the first time in the Factory, after controlling congruence on components and packages, components are registered by the informative system and catalogued as "components to analyze". To represent in the best way real operations, the simulating model flux has to be very close to the flow chart that we have seen in "Analyze" phase.

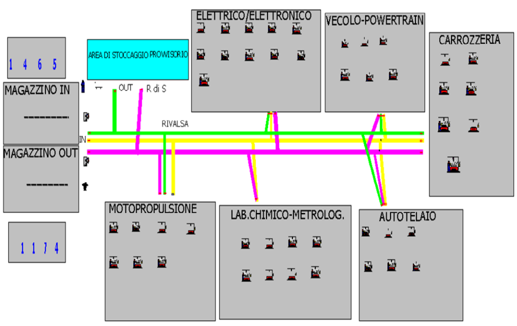

Fig.5 – The Simulation Model

The designed system needs 51 workers, that is 5 process operators, 1 recourse manager and 45 operators working at each diagnosis section:

CHASSIS: 6
CARBODY: 7
I.B.E. (Infotainment – Body - Electronic): 11
S.V.P. (Systems Vehicle - Power train): 6
MOTOR: 7
L.C.M. (Chemical - Metrological Laboratory)

Three different routes can be marked: they sign different causes for handling.
"Yellow route" is relative to the initial components distribution towards their sectors and to the components handling towards other sectors for an eventual second analysis. "Violet route" represents the expedition of some components to external laboratories for particular exams. "Green route" indicates the samples relocation because of recourse or definitive alienation.
In ARENA report there are three modules: these represent commands expressly built to register, on a Excel file, data that are interesting to the analyst. The first one reporting on WIP (Work In Process) tablet, indicates the number of components processed instantaneously. The second one shows components' lead time, realising periodical controls. These two indicators are very important for the essential need to size in a correct way the central storage, and to respect time for responsibility attribution, so as established in the specifications. To measure all above-mentioned things we used the WIP counter at the beginning and at the end of simulation layout; instead, the time counter is at the beginning and before of central storage gateway of components: in fact it's of paramount importance to control the time to make the diagnosis.

4 CONCLUSIONS

The DMADV approach explained in this paper is able to lead and to deploy a really new process design through deductive and exhaustive decision-routes. The development of the process with QFD brings us to manage the design in a systematic and organized way; so in every design step we have been able to underline the most important characteristics to push ahead and to define the guidelines to follow.
Another main topic that stands out from this work is the possibility to define some indicators to measure the process and the creation of the ARENA Simulation Model able to optimize the flow before its actual realization.
Simulator, in fact, is a tool able to predict the behaviour of a dummy or a changeable system. The achieved results, with their statistical reliability values, were very useful to the project team to know the right information and to make economical choices about human and technological resources' allocation and about central storage area's measurement. Moreover in this way we verified the time observance in order to realize diagnosis. So the fundamental possibility of the Simulation Model is to build a

prediction model that we can use also in the future if there are some changes in the process.

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