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Application of Value Engineering Concept to Engineering Change Management Process of Automotive Industry

Dase Sneha Somnath[1], Sangamesh Kishore M.[2]
[1] Mechanical Engineering Department, Shri Guru Gobind Singhji Institute of Engineering and Technology, Nanded, Maharashtra, India
[2] Information Technology Department, Nibana Solutions Private Limited, Chennai, Tamil Nadu, India

Abstract: ***The fast-growing movement of the modern societies shows increasing implementation of operational projects in the automotive industry to meet functionality improvement for minimizing defects in a part and improving its efficiency. As this automotive environment is experiencing great changes every day, industries must learn to become comfortable with these changes in order to sustain effectively in the marketplace. To fulfil the demands of customer and improving the time and cost statistics of a product there is need to develop a change management process workflow implemented with value engineering concept. This paper will discuss and analyze the need of engineering change management process, implementation of value engineering concept and the benefits of automated value engineering change process.***

Keyword: ***Product Life-cycle Management, Engineering Change Management, Value Engineering, Value Engineering Change Process, Product Development Process***

I. INTRODUCTION

In today's competitive world changes are very important in industry to successful launch of the product and management of data related to product over its entire lifecycle. Most of companies started launching number of products per year with its number of variants. Numbers of changes are occurring in components, during development phase and also during production phase with different reasons. Parts may get added, deleted, modified according to changes. So large amount of data gets generated and without automation of business process it is impossible to store and retrieve data in required time and with required flexibility. To achieve this nowadays different company uses Product Lifecycle Management (PLM) platform.

PLM innovates as it defines to aggregate enterprise information and lifecycle as a new time dimension for information integration and analysis. The goal of PLM activities is to realize benefits like reducing time-to-market, improving product functionality and increasing ability of customizing. Global competition is constantly causing more and more pressure on businesses to change their processes and operate more efficiently. The speed of changes is unparalleled and product life cycles are shortening. These changes in the business environment have made it more difficult than before to find the right product-related information and to maintain and retain the entirety of this information. The main reason for this problem is increase in the variations of products and huge amount of product information as the complexity of supply networks of companies had increased. [1]

II. VALUE ENGINEERING

At the present moment, global competition between companies is leading to a constant battle for an adequate market share and this is mostly not only achieved by reducing prices but rather more effectively by constantly introducing new innovations at all levels and across all functions in a company. Conceptions or ideas for new products derive either from external sources (as customers or buyers, suppliers, competitors, patent documentation, research centres and educational institutions, chambers, associations and institutes, fairs and exhibitions etc.) or internal sources (as managers, sales representatives, merchants and commercial travellers, associate professionals and technologists, designers, in-house innovators etc.). Companies use surveys, projective methods, group interviews as well as written customers suggestions and complaints to identify the needs and wishes of their customers. However, it has to be said that many of the best ideas evolve from the problems customers have with existing products. The very core of value engineering concept is the effort to determine and eliminate those characteristics of products or services with no real value for the customer or the product but which cause costs in the production process or service delivery. Therefore, the value engineering concept ensures a better product or service for the customer at minimal costs compared to replacing the existing product with a less favourable alternative. [2]

Automotive manufacturing firms operate in global competitive markets that transformed from sellers to buyers market. To prevail in this competition, manufacturing firms have to design products with lower costs and enhanced value

to the customer. This challenge expresses a reduction of the cost-value-ratio of a product. Value engineering approach aspire the increase of value of product through either an increase in functionality or a reduction of resources (e.g. costs). [3]

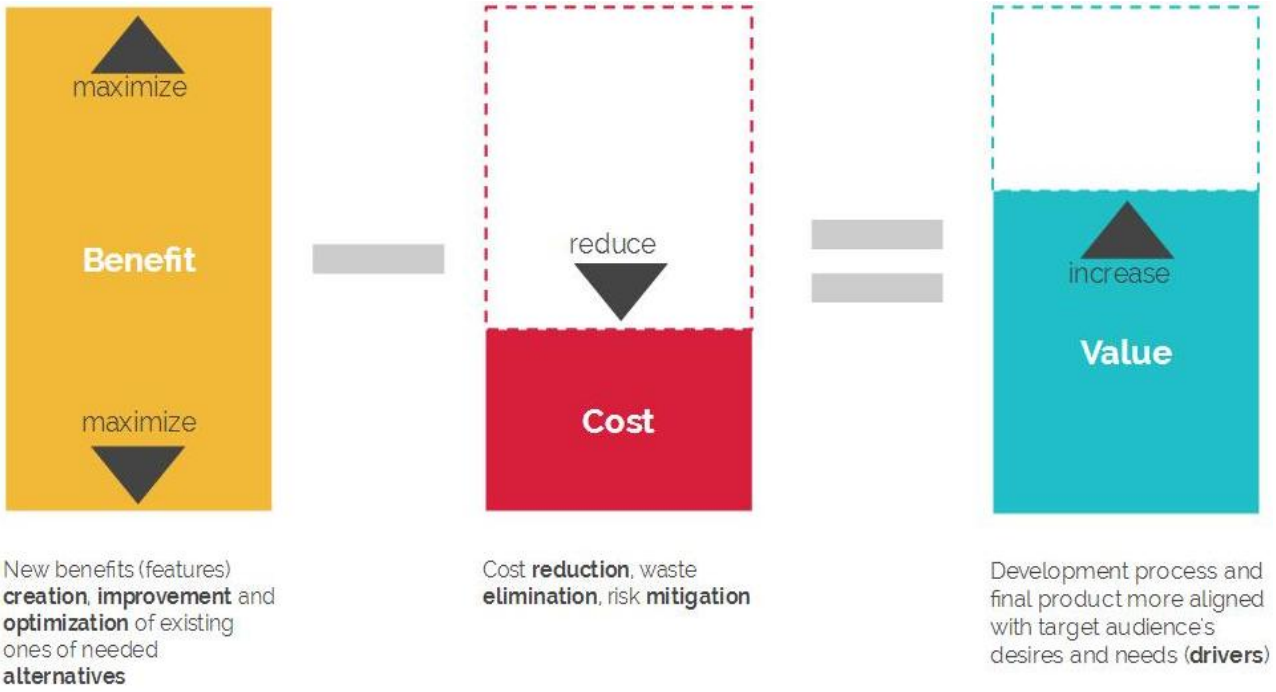

Figure 1. Value Engineering

The above figure gives a very straightforward definition of Value Engineering and brings to attention an important point that, maximizing benefits is not the only way to add value, reducing cost is equally important [4]. Thus Value Engineering is a technique for determining the manufacturing requirements of a product; it is concerned with its evaluation and finally the selection of less costly conditions. Value Engineering is a process for achieving the optimal result in a way that quality, safety, reliability and convertibility of every monetary unit are improved. [5]

III. ENGINEERING CHANGE MANAGEMENT

The automotive industry is faced to the challenges associated with a dynamic environment. The hard competition in the marketplace demands that the industries should develop and manufacture complex products with a higher performance and quality to a lower price than before to stay competitive. Alternating customer preferences, new regulations and competitive activities initiate changes in the product. The variety of models served markets and globally distributed production sites result in a highly complex system. In addition, fast moving markets and decreasing product life cycles of built-in units require decreasing reaction times. New roles, organizational units and duties have evolved to resolve the emerging tasks within this environment of product change management. Thus the realization of product changes has increasingly become a collaborative achievement with its organizational interfaces. These changes are managed effectively with a cross-functional team of automotive engineering experts to avoid wasting time, money and resources on incorrect parts. The old sequential way of performing product development and produce large series of expensive products is more and more turning into production of customer variants with a fast adoption to changing customer needs, knowing that the engineering change process can perform it quickly. An increased product complexity utilizing multiple technologies along with the shorter time for the product development processes makes it necessary to have more people with different skills involved in product development process.

Thus engineering change management has a crucial role in the automotive industry that helps to maintain the changes that occur in a product's life cycle. Every change must be properly assessed to determine the impact of the change and actions required to properly implement the change and notify to the customers. This change management within automotive engineering provides the discipline process to implement a change properly and with the least amount of disruption [6]. Today's business environment requires continuous improvement of business processes that affect productivity and profitability. This, in turn, requires organizations be open to and ready for change. ECM is needed for following issues:

- To know impacts of proposed changes
- To identify who is responsible for changes and who approved them
- To remove quality problems due to errors in change communication
- To Reduce the time, the organization spends too much on change control, approval of change request

An Overview of the steps of engineering change management process is represented in the following flowchart:

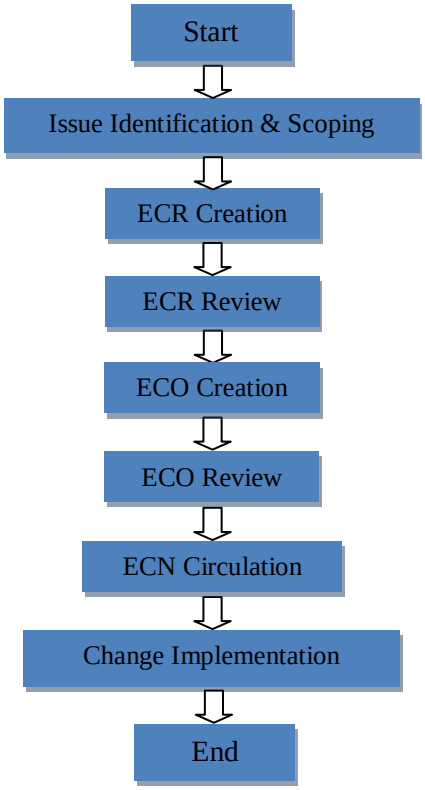

Figure 2. Engineering Change Management Process Flowchart

The stages of the engineering change management process are [7]:

1. **Issue identification & scoping:** Someone identifies a problem or issue and determines that it may require a change. The scope of the issue and its possible impact are estimated.
2. **ECR creation:** An engineering change request (ECR) is created to examine the necessity and feasibility of the change, to identify parts, components and documentation that might be affected, to estimate costs and to list the resources required to implement the change.
3. **ECR review:** The ECR is circulated for review and discussion among key stakeholders and is modified as needed.
4. **ECO creation:** Once the ECR is approved, an engineering change order (ECO) is generated, which lists the items, assemblies and documentation being changed and includes any updated drawings, CAD files, Standard Operating Procedures (SOPs) or Manufacturing Work Instructions (MWIs) required to make a decision about the change.
5. **ECO review:** The ECO is then circulated to a change review board made up of all stakeholders (including external partners when appropriate) who need to approve the change.
6. **ECN circulation:** Once the ECO has been approved, an engineering change notification/notice (ECN) is sent to affected individuals to let them know that the ECO has been approved and the change should now be implemented.
7. **Change implementation:** Those responsible for implementation use the information in the ECO and ECN to make the requested change.

IV. ENGINEERING CHANGE ORDER

Engineering change orders (ECOs) are part of almost every development process. They result from the fact that engineering is an iterative rather than a purely linear process and are traditionally targeted toward correcting mistakes, integrating components, or the fine tuning of a product. ECOs are also an outcome of the growing level of parallelism in today's development processes, where information absorbing downstream activities is often started prior to the completion of information-supplying upstream activities and thus have to rely initially on preliminary information.

An engineering change order is a documentation packet that outlines the proposed change, lists the product or parts that would be affected and requests review and approval from the individuals who would be impacted or charged with implementing the change [8]. Thus ECOs are used to make modifications to components, assemblies, associated documentation and other types of product information. ECOs are numbered documents that used to track product changes within the Engineering Change Management system. After testing and approving an ECO, those changes are implemented and thus standard product or process is modified as per requirement. Product changes can impact many areas within an organization, including:

- Customer service
- Tooling
- Standards

- Suppliers
- Master production schedule
- Product cost
- Service parts
- Inventory
- Plant layout

The change process starts when someone identifies an issue that may need to be addressed with a change to the product. It ends when the agreed-upon change is implemented. ECOs are used in between to summarize the modifications, finalize the details and obtain all necessary approvals. Following table shows some of the ECO features.

Table 1. ECO Features and Corresponding Description

Feature	Description
Define who approves the ECO	▪ Establish levels of approval, so that each member of the first review group must approve the ECO before the next group receives notification ▪ Locate the status of an ECO and review who has approved it and who has yet to approve it ▪ Use electronic mail to notify and approve ECOs ▪ Create and maintain bill of material data that is associated with the change ▪ Notify reviewers during the approval process ▪ Limit access to the approval records
Define which items to change	▪ Describe the change ▪ Define the parts and processes that are necessary to implement the ECO ▪ Include multiple parent item/process or component/ingredient relationships on the same change order
Define the change routing	▪ Itemize the steps required to make the change
Define additional detail	▪ Enter supporting data, such as costs, dates, reasons, status, affected work and purchase orders, approval history, and implementation steps into a centralized database ▪ Identify the originator and reason for the change ▪ Set up user defined codes to define reason, status, and disposition of the change order ▪ Attach supplemental information

The ECO process includes the following personnel:

1. The administrator sets up the ECO by:
   - Setting up the approval routing master
   - Reviewing and modifying the ECO codes
   - Setting up next numbers

2. The initiator creates the ECO by:
   - Verifying that no prior ECO exists for this change
   - Entering the ECO
   - Defining the change with a list of affected parent and component items
   - Establishing the new routing operations to implement the ECO
   - Maintaining supplemental details
   - Running the notification program

3. The reviewer approves the ECO by:
   - Reviewing the ECO after system notification.
   - Running reports with information for an individual ECO or a list of open ECOs
   - Indicating approval or rejection
   - Periodically checking for outstanding ECOs

A good ECO contains the full description, analysis, cost and impact of a change, and a good ECO process ensures that all stakeholders have bought in to the change. Having an organized method of handling product changes reduces potential design, manufacturing and inventory errors, minimizes development delays and makes it easy to get input from different departments, key suppliers and contract manufacturers. Good ECO practice also makes it easy to document a

full history of what changes have been made to a product and when they occurred. Keeping a record of product changes will also help to debug any problems that occur after product launches. The task of identifying and fixing the root cause of any problem is easier when we have a complete product change history. Without a clear ECO process in place, making a change to a product can set off a chain of costly, time-consuming and avoidable events.

Companies need to be able to adapt quickly in today's constantly changing environment and often that means making changes to their products. Modifications are made during development and production with the intent of adding functionality and improving manufacturing performance. To make sure proposed changes are appropriately reviewed, a solid process is essential especially if members of different departments are going to involve in that process. At the heart of a change process is the engineering change order. Thus Engineering change orders make it possible to accurately identify, address and implement product changes while keeping all key stakeholders in the loop and maintaining a historical record of product. Without them, miscommunications occur that lead to delays, incorrect purchase orders and improper product builds [8].

V. ELECTRONIC WORKFLOW SYSTEM FOR ECO

The purpose of change management procedure is to manage change requests so that approved changes will be controlled, ensuring the project remains on schedule, within budget and provides the agreed deliverables. The primary objectives of change management are to:

- manage each change request from initiation through to closure
- Process change requests based upon direction from the appropriate authority
- communicate the impact of changes to appropriate personnel
- allow small changes to be managed with a minimum of overhead

Different automotive industries use change management process for managing and tracking product changes and thus need an automation of Engineering Change Process. Automated electronic workflow software system significantly reduce the time needed to complete your design approval and engineering change order (ECO) processes with the automated electronic workflow software system. Automatically expedite the flow of information instead of managing engineering changes through manual or paper-based methods often so time-consuming that they require full-time staff to coordinate. Electronic workflow software system graphically depict processes using customizable flow charts and the system will automatically track, manage and enforce workflow ensuring that the right people have access to the correct files at each process stage to make its progress more efficiently. Comprehensive reporting tools show project status, so issues and delays can be addressed quickly. Reports also provide managers and executives with the information needed to improve processes and maximize profits.

Key electronic workflow capabilities include:

1. **Electronic Signatures and Approvals:** Use tools to coordinate the entire process electronically, instead of routing paper packets and drawings for signature and approval. The electronic workflow will circulate the appropriate files required for approval and send automatic notifications when approvals or rejections are executed.
2. **Process Automation:** Automate development processes by graphically modelling them in a flow-chart environment and evaluating them for redundancy or inefficiency. This capability enables identification of areas that could potentially be automated.
3. **Automatic Notification:** Configuration of electronic workflow to automatically notify users when a file or document has progressed through various stages in workflow.

Thus Electronic Workflow and File Routing graphically represent the product development process through an easy-to-use flow chart interface. And also it saves time, reduces costs and tightens security by using an electronic workflow which eliminates paper-based change packets and delivery requirements. Electronic workflow software system has following features:

- Automate file routing to make development and engineering change processes more efficient
- Send email notifications automatically when files change status from "Start" to "Pending Approval" for to keep everyone up to date
- Apply electronic signatures, with the option of a secondary password challenge to meet regulatory requirements
- Track the complete history of an approval as well as all the steps that preceded it
- Eliminate the guesswork about where files are in the approval process
- Remove paper from almost all engineering change process
- Create electronic engineering change requests quickly and easily associated with all affected files
- Add data automatically to documents like Microsoft Word and Excel files directly from system attributes
- Accelerate data entry and maintain consistency using standardized forms with customized inputs
- Notify other departments electronically (such as Purchasing or Manufacturing) when changes are underway

VI. CONCLUSION

The study proposes a module which will give benefits of automated Value Engineering Change Process for Automotive Industry. Previously, manual process of Value Engineering Change Process was being used. The engineering change process at the company was characterized by long and varying lead-times, fragmentation and featured major

iteration loops. A number of issues were identified including unclear roles, multiple documents and poor communication between the management peoples to take the approval decision. This automated Value Engineering Change Process will reduce the time to launch the product to market.

Main benefit of this study is to manage the documents in Engineering Change process. This study will help users to identify the factors which generally affect the failure of the products or processes. We can draw the following conclusions from the implementation of automated Value Engineering Change Process in Automotive Industry:

- The business requirement from the client to implement change management can be managed and documented well.
- This Allows to quickly respond to marketplace dynamics and provides with the option of expediting simple product changes or formally controlling complex changes
- Helps to integrates entitled suppliers and allied partners into change processes easily
- Enables decision makers to understand the business case that justifies a proposed change
- It ensures adherence to corporate standards and business rules and leverages continual improvement loops across your change processes

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