

ACTIVITY ANALYSIS OF NEW PRODUCT DEVELOPMENT

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Abstract: The industries which are influenced by customer needs, going through rapid change in global market. In India, industries are also rapidly growing by using best engineering practices in product development which directly and indirectly helps to increase profit through customer delight. This paper is used to show how an Indian organization is using rational design, empirical design, industrial design, design by experiment etc. in product development (PD). Different stages of development are monitored as per standard design practices and detailed analysis of product development activities of Indian manufacturer which makes Spray gun for construction industries.

Index Terms - Customer requirement (CR), Product design specification (PDS), Design for X(DFX), Modularity, Parametric design, detail design.

I. INTRODUCTION

In current market scenario best way to capture market or to maintain market share to provide latest or updated technology in product to customers. Therefore, product development in organization and new product development (NPD) team play a crucial role in this matter. New product development is a very complex in nature when its combined effect on regular production, marketing as well as in finance is taken. Long term survival of organization can be possible with customer satisfaction with profitability. Catering industry requirement or upgradation of working tools by making more systematic or infuse of automated mechanism provide edge in business. New product development work can be done in systematic way by using different stages of product development by specialized workforce with required priority within operation of organization. In India, small scale industries deputed few experts of different areas together to make a team to reduce time lag as well as to get advantage continuous, concurrent as well as iterative flow (if required) of process to develop new product. Once the team successfully develops the product, all documents containing design, drawing, process, material, assembly, precaution, manual, training process handed over to production department for production.

II. LITERATURE SURVEY

Erwin Rauch et al [1] have presented axiomatic design(AD) based guidelines for the design of lean product development (LPD) process based on waste reduction and value addition. A design matrix used in relationship of functional requirements (FRs) and design parameters (DPs). $\{FR\}=[DM]\{DP\}$. **Mohmed Kashkoush et al [2]** presented a mathematical model of selection for optimal overall product modularity in product design and development. Modularity is used to convert complex integrated product into simple one by clustering components, with reduced cost and ease of maintenance. **Piotr Chwastyk et al [3]** have discussed about estimating the cost of new product in development process by using different factor affecting costing and different methods like activity-based costing (ABC) and feature based costing (FBC). Several phases of product development like idea generation, idea screening, concept development and testing, marketing strategy, business analysis, product development, test marketing and commercialization having uncertainty in the result leads to have complicated parameters in costing. **Abraham Moody K et al. [4]** have presented an analysis of customer-oriented product development with quality function deployment (QFD). QFD is used to satisfy customer needs (CNs) by analysing the customer requirements (CRs) and have priority of needs which provide business process guideline for market-oriented method instead of product-oriented methods. Four phases product planning, part deployment, process planning and production planning used in QFD coupled with each other provide better way to select production goal.

III. CONVENTIONAL PRODUCT DEVELOPMENT PROCESS

Product is required to fulfil customer need with safety and used to have the desired goal of profitmaking for organization. Few key things are under consideration during product development stages are performance, reliability, durability, maintenance, features, aesthetic, conformance, cost [6]. Therefore, certain process or set of guidelines to be followed during different stages of product development.

Phases of Product Development Process in conventional product design process in organization based on particular steps. Four major steps are in product design and development

- Conceptual design
- Embodiment design
- Detail design

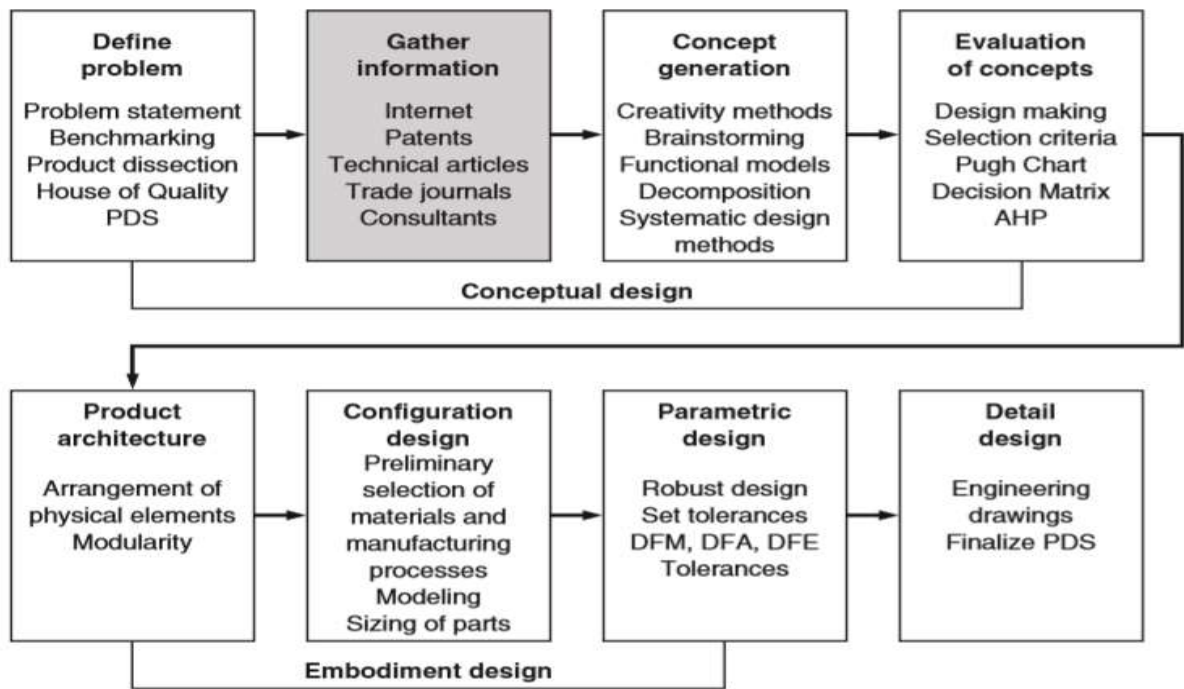


Figure 1 Engineering Design Process (George E. Dieter and Linda C. Schmidt. 2013 Engineering Design)

3.1 Define Problem

First stage of design is to understand customer need. House of Quality (HoQ) of Quality Function Deployment can be used for better understanding of voice of Customer (VoC) through different available information source. Product Design Specification is defined based on conversion of customer requirement into design attributes. Engineering characteristics includes parameter design variables and constraints which are defined as per level wise requirement of customer needs like expecters, spokens, unspokens and excitors Benchmarking and reverse engineering can be used for finalizing PDS.

3.2 Gather Information

Information are required to create product more technologically updated, value for money, current trends and restrictions. Information regarding customer, related design, design analysis, selection of material, manufacturing process, costing technique, standards, regulations and life cycle issues of product are required during different design phase. Different sources which are used for gathering information are Libraries, internet, consultants, government database, different professional societies and trade associations, patents, copyrights, trademarks, customer survey and customer feedback etc.

3.3 Concept Generation

World is full of creativity. In product design different processes can opted to create new concept. By using discussion of experts in group, why-why analysis, brainstorming concepts related to product design are listed. Functional decomposition, morphological method, theory of inventive problem solving TRIZ can also be used for the concept generation. Concept of rational design with the help of experts is useful for creating different new concept.

3.4 Evaluation of concepts

This step is very important because wrong selection of concept may delay the project as well as financial losses may be possible. Decision tree, Pugh concept selection method, weighted decision matrix, Analytic Hierarchy Process can be used as per required type of decision making with suitable database and different tools.

3.5 Product Architecture

The arrangement of parts to do the required performance in product is called product architecture. It deals with different types of modularity, interface and different possible layout. Types modularity as per

- Interface used
 - Slot-modular
 - Bus-modular
 - Sectional-modular
- Production Strategy
 - Component-sharing modularity
 - Component-swapping modularity
 - Cut-to-fit modularity

➤ Platform modularity

Four step process [7] for creating product architecture.

- Create a schematic diagram of product
- Clustering of schematic elements
- Rough geometric layout
- Identification of interactions between modules

3.6 Configuration design

This part of embodiment design deals with selection of material, form, respective production process. Interfaces and connections are used based on available degree of freedom. Industrial engineering is also used to ensure form and shape of the component also enhance aesthetic of product.

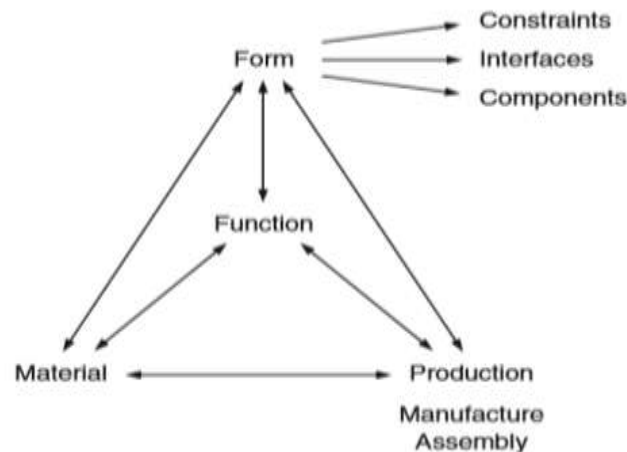


Figure 2 Interrelationship between function, form, material and production process

Basic guidelines [8] for configuration design as follows

- Clarity of functions and priority when interaction between function (Braking and steering in automobile).
- Simplicity of components to reduce information content.
- Safety (guards, warning labels).
- Minimal impact on the environment

Assembly guidelines (components) for sub-assembly to be decided during this phase depending upon interface and connections. Following are the different connection between components

- Fixed and nonadjustable connection
- Adjustable connection
- Separable connection
- Locator connection
- Hinged or pivoting connection.

3.7 Parametric Design

The last part of embodiment designs deals with robustness which refers achievement of required performance under widely range of inputs. It deals with design variables, reliability, safety, dimensions, tolerances. Industrial design deals with visual aesthetics, human factors (ergonomics), are applied during this stage. Prototyping and testing of prototype using CAD model, rapid prototyping can be done in this phase. Design for X, where X refers a performance measure of design. Following are different type of design methodology:

- Design for Manufacture (DFM)
- Design for Assembly (DFA)
- Design for Environment (DFE)
- Design for Manufacture and Assembly (DFMA)

3.8 Detail design

Detail design is the last stage of design before handing over of product to production department. Change of product design specifications properly are recorded for reference and further decision making. Prototype is manufactured and testing and trial is done based on customer requirement and functional requirement. Following steps are required to follow during this stage make and buy decision, complete engineering drawings, complete bill of material, final cost estimation, design project report, release design to manufacturing.

IV. IDENTIFICATION OF DESIGN ACTIVITIES OF AN INDIAN ORGANIZATION

This paper is taken a survey of an Indian original equipment manufacturer (OEM), which manufactures different equipment of construction industries. Development of spray gun(product) is analyzed; here only type of wall to be plastered information given by customer or marketing team. Product development operations start with receipt of information. All activities from receiving of requirement to delivery to customer side are tabulated below.

Table 1 Activity mapping of Spray Gun (Product) development

S No	Activity	Description
1	Requirement receiving	Requirement of customer or marketing team is arrived. Information regarding types of wall to be plastered provided to design team.
2	Selection of team	Assignment of person for overall coordination.
3	Assigning of project	Select required team to complete the project for creating new concepts or modifying existing product and analysis.
4	Study of customer requirement	Study the requirement of customer with critical points to be taken care of.
5	Study available similar type of product in market	Compare with available product in market to make value for money for customer.
6	Study available materials in market regarding specific operation and parts	Study of existing and new material available in market and if specific operation required to complete the product
7	Complete Product design specification (PDS)	Complete technical specification for product and finalize bought out parts
8	Sent PDS to customer	Send PDS to customer for final approval for different rating (compressor and capacity of storage) confirmation and interface selection if required at site.
9	Technical data approval from customer	Get an approval from customer (Send communication like that if within time period customer does not reply can be taken as acceptance of proposal)
10	Complete general assembly drawing	Complete general assembly (GA) drawing for customer as well as for assembly and quality checking purpose
11	Complete assembly drawing (Module)	Complete parts drawing with technical point of view (calculation of loads), shape and size and module drawing. Define type of modularity can be used, component sharing, component-swapping, cut-to-fit or platform.
12	Define interface for module	Define interface for different module and recheck with matching module with respect to flow of material, energy, signal etc. General module comprises of storage unit, compressor unit, holding and control unit and spray unit. Depending upon application and strategy slot, bus or sectional modularity can be used.
13	Checking of tolerance	Check dimension, tolerance (dimensional and geometric) of parts drawing.
14	Complete bill of material	Complete stage wise bill of material for component, sub-assembly, assembly
15	Complete drawing in Auto-cad	Complete 3-D modelling to ensure complete cross checking for functioning and fitment
16	Checking of assembly in Auto-cad	Checking of individual assembly in software regarding quality parameter, assembly process and different degree of freedom (DOF)
17	Finalization of standard component	Finalize the bought-out (standard component) items specification (selection of supplier in case of specific need) for purchasing purpose. Depending upon scope of supply to the customer.
18	Making jigs and fixture.	Design of required jig and fixture if required as production resource tool (PRT)
19	Procurement of material	Procurement of material (raw material, standard component, special purpose component)
20	Prepare quality plan	Quality plan for component and production are made simultaneously
21	Manufacturing of parts	Metal cutting, fabrication, machining of component, heat treatment
22	Checking of parts with Go and No-Go gauge	Quality check of components for interchangeability with suitable gauges
23	Sub-assembly of component	After receiving of component, complete the sub assembly and checking the quality parameter

24	Trial of product	Trial of product as per functional requirement, quality check of critical to quality (CTQ) functions. Production rate, power rating, holding and spraying of product.
25	Painting of product	Complete product by painting as per required shade (if customer has specific requirement)
26	Create product variants	Once the basic product established, variants of product can be created for different types of customer
27	Finalization of Product specification	Finalization of Product specification of different variants for marketing, catalogue and promotions
28	Complete variant modelling	Complete 3-D modelling of newly created model variants
29	Complete Variant bill of material	Complete bill of material for every variant of product module wise.
30	Complete Variant costing	Complete product costing of every variant of product for better negotiation and offer to customer
31	Complete project report	Before handing over to information to production and marketing department complete detailed project report is made and get it approved from proper authority
32	Handover to production team	Handover of complete (required) detail to production and marketing department with proper documentation.



Figure no 3. Sample Product: Spray Gun (M/s Lakshmi Machine Tools, Indore)

IV. RESULTS AND DISCUSSION

This paper through analysis of activities and their relationship in product design in Indian organisation gives vital information of product design. The relationship between eight phases of standard product field and activities in organisation can be easily understand from following table.

Table 2 Relationship of activity and product development process stage

Product Development (PD) Phases	Activity involved (S No)
Define Problem	1,4,5,7,8,27
Gather information	6,15
Concept Generation	2,3
Evaluation and selection of concept	9
Product Architecture	10,12,26
Configuration Design	11,16,17,25,28
Parametric Design	13,18
Detail Design	14,19,20,21,22,23,24,29,30,31,32

Sustainability is major issues of organization, and can be achieved by profitability which is solely depends on customer delights. Customer satisfaction is most critical parameter to understand during product development process. Product development team must ensure that product fulfil all levels of needs (expecters, spokens, unspokens and exciters) must be met during product development stages.

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