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Rational Design Approach in Electronic Engineering Design

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Abstract
Rational design approach has an important role when planning to design any system in engineering. The essence is to help engineers to set a pattern and direction on what and how to make the system that will solve and effectly perform a particular job at a reduced cost and harm to the end users. Recently, many systems has been developed, improved and invented by the engineers making simple and more human friendly of which most of them are sophisticated and difficult systems to be manged.
This process was been achieved by their critical and rational reasoning to research and comparing existing system and the problems encountered to design a preferable and more reliable system.
However, in this paper the types of designs, steps, approaches and the goals of a design methodology.

Keywords: Design Approach, Design Process, Design Methodology

Introduction
Design can be defined as the creation or formulation of a plan which will enable the designer to build a product with a desired specification.
However, a design can be said to be rational in approach when there are explicit documentation of the reasons behind the decisions made when designing a system.
There are different types of engineering design models, they are

- Configuration design
- Parametric design
- Selection design
- Innovation design
- Creative design

Selection Design: This is a type of design where the engineer decides to choose or select and already existing design to form a new design in meeting up a particular task.
This design can be of component selection or system selection for modernization.

Configuration Design: In this type of design model, the designer deals with the reconfiguration of a system property. Thus, this could be due to an outdated version of the system present configuration to an updated version of the system.

Parametric Design: This is a type of design that considers the parameters to be used.
Wherefore, the values of the parameters and components are meant to be valued to replace the existing ones. It can be regarded also as a process of upgrading the components of the system in achieving a better result.

Redesigning or Innovative: This is a type of design which focuses on redesigning of an existing system for a more efficient idea. This might be pointing;

- To reshaping of the system,
- To reduce the cost of its operation,
- To improve its efficiency and
- To make the system more human friendly to use.

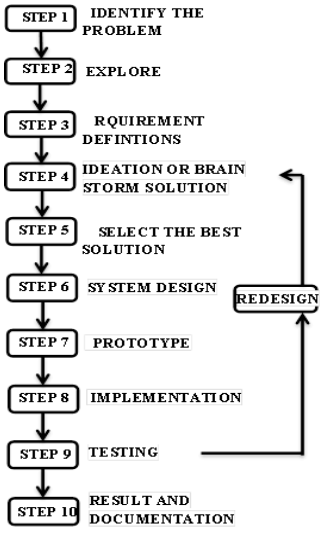
Creative or Original Design: This type of design states the new start to form a system. It approach is completely new and has a particular and different assignment to solve from already existing systems and designs. The engineer tends to evaluate his resources, develop a new idea and model to be able to solve the challenging state.

Procedure in Achieving a Desired Design: For a design to be rational in its approach and implementation, it must have a standard methodology on what the designer have in mind, states his objectives and evaluates them accordingly to achieve his desired results.
In a design methodology, it is said to be an orderly and logical approach or procedure for performing a particular task with a constant applications in following a pattern.

Qualities of a Good Design

1. Functionality: The system must be able to meet up the required functions at which it was design. It must satisfy the produce solution to the need of the engineer.
2. Reliability: The system must be able to maximize reliability to produce a reasonable result, which is obtainable and satisfactory.
3. Efficiency: The result obtained and working principle must be effective. The design should give the smallest experimental error and yields maximal information by creating an opportunity for considering other different aspects of a problem.
4. Understandability: The system must be human friendly to the users in other to relate a good working experience and less difficulty in managing and handling it.
5. Modifiability: as a design, it should be able to be modifying from one state to another to suit a new developed ideas.
6. Economical**:** The designed system must be built in a lower cost reduction; it has to be an economic system where much cost will not be much both in manufacturing and maintenance of the design
7. Low Risk Factor: The design should not be hazardous to the health of human being, causing damages to the users.
8. Maintainability: It should be easily amenable to change in an easily manner.

Steps of a Design Approach



Identify the problem
Thus, before any design can be implemented, there has to be a motive and a conceptual ideal towards it either by trying to improve an already existing units or components or creating something brand new to meet up a particular task or needs. There has to be a concept laid down for the design by asking "HOW CAN" this problem the fix and what are the things to be done to achieve the design proper.

Explore
The designer must be able to seek and make researches on how to sort for the resources need for the work to be achieved. He states, evaluates and analyzes the environment, develop the specifications (set of requirements to be satisfied by system). However, he makes research on similar and related designs, methods are also viewed during this step in order to set up a standard system against the already existing ones. The designer tends to know the problem

- Who has the problem?
- Why it is important to solve the problem and with what is required to solve it.
- However, this helps to develop an algorithm for the design.

Rquirement Defintions
In this step, the engineer states the important characteristics and basic requirements in choosing and selecting the best solution and components that best suits the design in other to meet up to his goal.
In order words, to achieve this, existing products must have been well analyzed and evaluated taking in considerations the key features needed also he must be able to define the problem properly. Above all, in selecting a specify requirement, the engineer has to state these conditions:

i. Design brief worksheet
ii. Design requirement examples
iii. How to analyze a physical product
iv. How to analyze a software product
v. How to analyze the environment

Ideation or Brain Storm Solution
In considering a good and rational design, brainstorming is one of the most important steps to be applied. This step encourages the engineer to develop multiple choices and solutions. Different solutions and findings are obtained and the best that suits the challenging factor is been selected at the end.
Moreover, this creative process of developing ideas is known as ideation. Alternatives and ideas are put in view wherefore, they designer has no option to settle on one thus he must

- Examine existing solutions
- Creating and using analogies
- Conducting brainstorming sessions and then sketching and choosing the best out of many possible ideas derived.

Select the Best Solution
This step follows immediately after brainstorming process out of the multiple options the best is meant to be chosen and followed.
In choosing the best solution, you must check whether the

possible solutions derived can be able to meet up to the task then consider the best application. The designer tends to focus on the system restraint robustness, aesthetics (appearance), cost of manufacturing and maintenance of the system, available of the resources need, time required, skill required and the safety of the system to human use. These criteria should be observed before choosing the best solution for a design.

System Design

This forms different units into blocks (functional blocks) or modules.

Each unit is designed in terms of interacting units and must be refined known as step-wise refinement.

At this step, the engineer is expected to develop a solution and to implement them. A comprehensive developed work should be stated in a drawing and other forms like prototype etc.

The aims of first stating and interpreting the design in a drawing and other forms are:

- To make it work
- To observe the possible risk to occur
- Optimize success
- Study the system possible principle of operation.

Therefore, to study and achieve all these, the engineer uses drawing, modeling, prototyping, storyboards and Analysis to obtain his result.

Drawing: This is one of the methods used in developing a system design. A proposed work can first be communicated and illustrated with drawings in order to evaluate the possibility of it implementation.

There are several ways of doing this:

i. Sketches: this is a rough freehand representation of a work which majorly shows the outlines of the design.
ii. Pictorial drawings: this is the use of pictures to explain the expected design of the system in a pictorial drawing and format.
iii. Technical drawing: this type of drawing displays the accurate technicality of the design in view. It explains the size and shape, thus it is often done with CAD (computer Aided Design software) to construct the design in detail manner.
iv. Modeling: designs can also be modeled using computer software such as MATLAB to observe the system physical and scale parameters.
v. Storyboards: this method deals on series of graphic illustrations or imagines for the purpose of visualizing a video, website, software program etc. it shows the behavior of the system and its intending physical interactions with the users as well as the challenges.
vi. Prototyping: this model is known to be the first full scale and usually functional form of a new design of a construction which assists the designer to checkmate the possibility of achieving a good result at the end of the design.

Prototype

Prototypes are a key step in the development of a final solution, allowing the designer to test how the solution will work.

- A prototype is an operating version of a solution. It is often made with different materials (cheaper and easier to work with) than the final version, and generally it is not as polished.
- Prototypes allow you to test how your solution will work and even show the solution to users for feedback.
- Creating prototypes may involve using readily available materials, construction kits, storyboards, or other techniques that help you to create your solution quickly and with little cost. Keep in mind that these are mockups of your final solution, not the real thing!

Implementation

This involves the physical (hardware) connections of the blocks (units) to couple the system in an appropriate manner. Thus, it can also be the software configuration of the system in order to link it to the other functional units of the system.

Testing and Redesign

The design process involves multiple iterations and redesigns of your final solution. The design should be tested after the solution has been set to evaluate if there are any new problems, make changes, and test new solutions before settling on a final design.

The parts of the design can be tested simultaneously or by parts such as:

Unit testing: this is known as debugging, which deals with different testing of the units individually to know the responses of the units in the system. Errors identify can be easily corrected within that unit.

Integration testing: it is a phase in software testing in which individual software modules are combined and tested as a group. It occurs after unit testing and before validation testing.

System testing: a complete and integrated system test. The purpose of this test is to evaluate the system's compliance with the specified requirements. It is the process of testing an integrated system to verify that it meets specified.

The system is redesigned if it fails to meet up the required task and need of the designer.

Result and documentation

After the final testing, if the system is confirmed good it is said to have satisfied its purpose of designing of which documentation follows. The manufacturer creates a comprehensive manual which will guide the user to handle and understand the principle of the system.

Goals of a design methodology

1. The methodology must be flexible for others to understand.
2. A methodology should be reproducible such that two or more persons applying the methodology to the same problem will produce the same or approximate result.
3. The design must be able to meet the users target and objective with a good structural pattern. It must be able to produce useful structure within a reasonable time. Also, it must adhere to the system constraints.

Conclusion

Possibly the most important goodness criterion is design correctness. A design has to be correct to be acceptable. Given that a design solution is correct, understandability of a design is possibly the most important issue to be considered while judging the goodness of a design. A

design that is easy to understand is also easy to develop, maintain and change. Thus, unless a design is easily understandable, it would require tremendous effort to implement and maintain it.

Reference

1. David Lorge Parnas and Paul C. Clements: A Rational Design Process: How and why to fake it.
2. Hongshen Ma, Fundamentals of Electronic Circuit Design.
3. Jan Bredereke: SCS4: Engineering of Embedded Software Systems, WS 2002/03
4. K. M. Kim and K. P. Lee, Two types of design approaches regarding industrial design and engineering design in product design.
5. P. F. Culverhouse, four design routes in electronics engineering product development.
6. Sachin Chaturvedi; Lecturer in Department of Mechanical Engineering Design Philosophy.
7. Seyyed Khandani, Ph.D. Engineering Design Process.