DETAILED DESIGN

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IMPORTANT DEFINITIONS

DETAILED DESIGN

A group of tasks used to finalize a product design that meets the requirements and design approach defined earlier.

- Requires decisions, even though some technical information may not be available. The design team must use "best estimates," otherwise known as assumptions, to develop the design.
- Unless the design is thoroughly analyzed, this situation increases the probability that the design is inadequate or incorrect. Good analyses and models can remove much of this uncertainty.
- Design analysis, modeling, and simulation are design techniques used to assist the development team in substantiating those assumptions, which will increase the chance of a correct design and reduce the technical risk in product development.

DESIGN ANALYSIS

Use of scientific methods, usually mathematical, to examine design parameters and their interaction with the environment.

- The purpose of analysis is to gather enough information to improve our knowledge of a situation so to make better decisions.
- Its goal is to reduce technical risk. Since the team uses so many assumptions, design is often thought of as an iterative or continuous process of design, analysis, and test that utilizes the knowledge available at a given time.
- Examples of knowledge include rules of thumb, published standards, textbooks, databases, and results from analysis, modeling, simulation, and testing. The processes of design analysis, modeling, and testing are used to ensure that a design is appropriate.

MODELING AND SIMULATION

Tools for evaluating and optimizing designs, services and products.

- **Purpose is to assist the design team in the development of a product.**
- **They constitute a process in which models simulate one or more elements of either the product or the environment. The metrics for modeling depends on the analysis being performed**

BEST PRACTICES FOR DETAILED DESIGN

(i) Design analyses and trade-off studies are systematically conducted in a collaborative manner to ensure that a design and its support systems can meet or exceed all design requirements.

(ii) All disciplines including manufacturing, reliability, testability, human engineering, product safety, logistics, etc. are included

(iii) Design synthesis and high-level design tools are used to increase design quality and efficiency.

(iv) Modeling and simulation are extensively used for design analysis, trade-off studies, and performance verification

(v) Analyses contain sufficient detail to accurately model the "real world" including:

- Variability and uncertainty
- Worst-case, parameter variation, and statistical analyses
- Aging

(vi) Stress reduction including mechanical, thermal, and environmental improves reliability and quality.
(vii) Failure modes analysis such as failure modes and effects analysis (FMEA), production failure modes analysis (PFMEA) and fault tree analysis (FTA) are used to identify and then correct or minimize potential problems.

DESIGN ANALYSES

- Design analysis disciplines may include digital circuit, analog circuit, printed circuit board, software, mechanical structure, plastics, etc.
- Support disciplines include manufacturing (producibility), testing (testability), logistics, reliability, etc.
- Effectively coordinating these disciplines is a difficult process.
- Computer-aided design, knowledge bases and networks are areas of technology that is being used by many companies to assist in the transfer of knowledge and information between the design team. These systems have access to databases and the Internet that can contain:

  (i) CAD drawings and parts, software and materials data

  (ii) Vendor history and information

  (iii) Design rules and lessons learned (both corporate and product specific)

(iv) Design and support specifications and guidelines (scenarios, product use profiles, performance, producibility, reliability, supportability, and design to cost)
(v) Detailed producibility criteria (capabilities of special and standard processes, testability, and estimated production quantity)
(vi) Detailed reliability criteria (reliability models, failure history, physics of failure, failure mode information)
(vii) Results from prototype testing

- Advanced CAD and design automation systems allow users to create concept models easily and quickly using digital sketching or mathematical models.
- Networks allow the design team to evaluate many concepts in a short period of time.
- In the future automated design advisors and agent based analysis technologies will allow product generation and evaluation to be completed almost instantaneously.

- **Paperless designs** automatically determine how the parts could be manufactured and assembled.
- Data from **projects that have implemented** computer-aided engineering tools indicate that **design cycle time can be reduced as much as 60%**, while producing equal or superior product quality (Swerling, 1992).
- **Design trade-off studies** examine alternative design approaches and different parameters for the purpose of optimizing the overall performance of the system and reducing technical risk.
- Trade-off studies are directed at **finding a proper balance** between the many **demands on a design**.
- The goal is to **prevent problems** rather than fixing them later. Otherwise, the analyses merely record information about the design after the fact. Changes made later in a program are more costly and less likely to be incorporated.

References

1. Karl T. Ulrich and Steven D. Eppinger (2009), Product Design and Development, 4th Edition, Tata McGraw-Hill Publishing Company Limited, ISBN: 978-0-070-14679-2
2. Stephen C. Armstrong (2005), Engineering and Product development Management– The Holistic Approach, Cambridge University Press, ISBN: 978-0-521-01774-9.
3. Ibrahim Zaid (2006), Mastering CAD/CAM, 2nd Edition, Tata McGraw-Hill, ISBN: 978-0-070-63434-3.
4. Anoop Desai, Anil Mital and Anand Subramanian(2007), Product Development: A Structured Approach to Consumer Product Development, Design, and Manufacture, 1st Edition, Butterworth-Heinemann, ISBN: 978-0-750-68309-8.
5. S. J. Hu, Evolving paradigms of manufacturing: From mass production to mass customization and personalization, in: Procedia CIRP, volume 7, Elsevier B.V., 2013, pp. 3–8. doi:10.1016/j.procir.2013.05.002.
6. S. Jung, T. W. Simpson, New modularity indices for modularity and clustering of product architecture, Journal of Engineering (2017) 1–22. doi:10.1080/09544828.2016.1252835.

Thank you