北京理工大學

Beijing Institute of Technology
Bachelor's Thesis

Thesis title

School： School of Mechanical Engineering

Degree： Bachelor of Science in Mechanical Engineering

Author：

Student ID:

Supervisor：

Co-Supervisor:

Delete if you don't have co-supervisor

June 5 2021

北京理工大學

Bachelor's Thesis Specifications

Category: Bachelor's Thesis

Type:

批注 [Z. XU1]: Options of type (specified in the online system)
Engineering Design
Engineering Technology Research
Theoretic Research
Software Development

Thesis Title

School: School of Mechanical Engineering

Degree: Bachelor of Science in Mechanical Engineering

Author:

Student ID:

Supervisor:

Co-Supervisor:

Delete if you don't have co-supervisor

DESCRIPTION:

SPECIFICATIONS:

Signed by supervisor

Data is in January 2021

Signed by supervisor's institute header

rvisor __________________ Date __________________

Header of Institute __________________ Date __________________

Program Leader __________________ Date __________________

I will sign later, leave it blank.

毕业设计（论文）指导教师评语表 Supervisor Assessment

指导教师对毕业设计（论文）的评语：Supervisor Assessment:

Print comments of supervisor.

Signed by supervisor, date is before June 7 2021

Supervisor:________________(Signature)

Date: __________________.

毕业设计（论文）匿名评阅评语表 Assessment Form I

学生姓名		学号	
学院		专业	
题目			
评阅结果			

评语：

Insert the PDF assessment form downloaded from the system

评阅人：

年　　月　　日

毕业设计（论文）匿名评阅评语表 Assessment Form II

学生姓名		学号	
学院		专业	
题目			
评阅结果			
评语：			
评阅人： 年　　月　　日			

毕业设计（论文）答辩评语表 Assessment Form of Defense

答辩委员会（小组）成员 Defense Committee			
Committee Member	Professional Title	Role	Signature
张旭 Xu Zhang	Associate Professor	Chairman	
解丽静 Lijing Xie	Associate Professor	Member	
黄杰 Jie Huang	Associate Professor	Member	
王俊升 Junsheng Wang	Professor	Member	
史玲玲 Lingling Shi	Associate Professor	Member	
张海波 Haibo Zhang	Associate Professor	Member	

答辩中提出的主要问题及回答的简要情况 Questions and answe defense:

Leave it blank

Write down 3 questions been asked in the defense, and brief answers. Should be in one page.

Leave it blank

Representative of the Defense Committee ______________(Signature)

______________(Date)

答辩委员会（小组）的评语 Comments of Defense Committee:

I will give you this page with comments and grade. Don’t print this page.

Representative of the Defense Committee ____________(Signature)

____________(Date)

答辩委员会（小组）给定的成绩 Score of Thesis：

Chairman of the Defense Committee ____________(Signature)

____________(Date)

Start Date: 年(Y) 月(M) 日(D)

End Date: 年(Y) 月(M) 日(D)

Date of Defense: 年(Y) 月(M) 日(D)

原创性声明 Statement of Originality

本人郑重声明：所呈交的毕业设计 … 师的指导下独立进行研究所取得的成果。除文中已经注明 … 任何其他个人或集体已经发表或撰写过的研究成果。对本 … 人和集体，均已在文中以明确方式标明。特此声明。

Print your name

I,________, solemnly declare: th … gn (thesis), is the research achievement completed independently by myself under the guidance of the supervisor. This article does not contain any research published or written by any other individual or group, except as already referenced in this paper. Individuals and groups that have made important contributions … s paper are clearly indicated and cited in the paper.

Sign

Student (Signature): __________________ Date: _____________________

关于使用授权的声明 State of Use Authorization

本人完全了解北京理工大学有关保管、使用毕业设计（论文）的规定，其中包括：①学校有权保管、并向有关部门送交本毕业设计（论文）的原件与复印件；②学校可以采用影印、缩印或其它复制手段复制并保存本毕业设计（论文）；③学校可允许本毕业设计（论文）被查阅或借阅；④学校可以学术交流为目的，复制赠送和交换本毕业设计（论文）；⑤学校可以公布本毕业设计（论文）的全部或部分内容。

I fully understand the regulations on the storage, use of graduation design (thesis) in Beijing Institute of Technology. Beijing Institute of Technology has the right to (1) keep, and to the relevant departments to send the original or copy of this graduation design (thesis); (2) copy and preserve this graduation design (thesis) by photocopying, miniature or other means of reproduction; (3) allow this graduation design (thesis) to be read or borrowed; (4) for the pu … exchange, copy, give and exchange this graduation design (th … ll or part of the contents of this graduation design (thesis).

Sign

Student (Signature): ________________ Date: ____________________
Supervisor (Signature):_______________ Date: ____________________

Thesis Title

Abstract

Conventional product development employs a design-build-test philosophy. The sequentially executed development process often results in prolonged lead times and elevated product costs. The proposed e-Design paradigm employs IT-enabled technology for product design, including virtual prototyping (VP) to support a cross-functional team in analyzing product performance, reliability, and manufacturing costs early in product development, and in making quantitative trade-offs for design decision making. Physical prototypes of the product design are then produced using the rapid prototyping (RP) technique and computer numerical control (CNC) to support design verification and functional prototyping, respectively.

Key Words: Computer-Aided Design; FEM; CAM

Table of Contents

Abstract ii
Table of Contents iii
Chapter 1 Introduction 1
1.1 Introduction 1
2.2 Background 1
Chapter 2 Identifying Customer Needs 3
2.1 Method of study 3
2.1.1 Process of identifying customer needs 4
2.1.2 Development process 4
Chapter 3 Engineering Design 6
Conclusions 8
References 9
Appendix 10
Appendix A Design Structure Matrix Example 10
Acknowledgement 11

Chapter 1 Introduction

Conventional product development is a design-build-test process. Product performance and reliability assessments depend heavily on physical tests, which involve fabricating functional prototypes of the product and usually lengthy and expensive physical tests. Fabricating prototypes usually involves manufacturing process planning and fixtures and tooling for a very small amount of pro- duction. The process can be expensive and lengthy, especially when a design change is requested to correct problems found in physical tests.

1.1 Introduction

In conventional product development, design and manufacturing tend to be disjointed. Often, manufacturability of a product is not considered in design. Manufacturing issues usually appear when the design is finalized and tests are completed. Design defects related to manufacturing in process planning or production are usually found too late to be corrected. Consequently, more manufacturing procedures are necessary for production, resulting in elevated product cost [1].

With this highly structured and sequential process, the product development cycle tends to be extended, cost is elevated, and product quality is often compromised to avoid further delay. Costs and the number of engineering change requests (ECRs) throughout the product development cycle are often proportional according to the pattern shown in Figure 1.2 [2]. It is reported that only 8% of the total product budget is spent for design; however, in the early stage, design determines 80% of the lifetime cost of the product (Anderson 1990). Realistically, today's industries will not survive worldwide competition unless they introduce new products of better quality, at lower cost, and with shorter lead times. Many approaches and concepts have been proposed over the years, all with a common goal to shorten the product development cycle, improve product quality, and reduce product cost.

2.2 Background

A number of proposed approaches are along the lines of virtual prototyping [Number of paragraph in the referred reference], which is a simulation-based method that helps engineers understand product behavior and make design decisions in a virtual environment. The virtual environment is a computational framework in which the geometric and physical properties of products are accurately simulated and represented. A number of successful virtual prototypes have been reported, such as Boeing's 777 jetliner, General Motors' locomotive engine, Chrysler's automotive interior design, and the Stockholm Metro's Car 2000 [3]. In addition to virtual prototyping, the concurrent engineering (CE) concept and methodology have been studied and developed with emphasis on subjects such as product life cycle design, design for X-abilities (DFX), integrated product and process development (IPPD), and Six Sigma.

Chapter 2 Identifying Customer Needs

A successful hand tool manufacturer was exploring the growing market for handheld power tools. After performing initial research, the firm decided to enter the market with a cordless screwdriver. Exhibit 5-1 shows several existing products used to drive screws. After some initial concept work, the manufacturer's development team fabricated and field-tested several prototypes. The results were discouraging. Although some of the products were liked better than others, each one had some feature that customers objected to in one way or another. The results were quite mystifying since the company had been successful in related consumer products for years. After much discussion, the team decided that its process for identifying customer needs was inadequate.

2.1 Method of study

This chapter presents a method for comprehensively identifying a set of customer needs. The goals of the method are to:

- Ensure that the product is focused on customer needs.
- Identify latent or hidden needs as well as explicit needs.
- Provide a fact base for justifying the product specifications.
- Create an archival record of the needs activity of the development process.
- Ensure that no critical customer need is missed or forgotten.
- Develop a common understanding of customer needs among members of the development team.

The philosophy behind the method is to create a high-quality information channel that runs directly between customers in the target market and the developers of the product. This philosophy is built on the premise that those who directly control the details of the product, including the engineers and industrial designers, must interact with customers and experience the use environment of the product. Without this direct experience, technical trade-offs are not likely to be made correctly, innovative solutions to customer needs may never be discovered, and the development team may never develop a deep commitment to meeting customer needs.

2.1.1 Process of identifying customer needs

The process of identifying customer needs is an integral part of the larger product development process and is most closely related to concept generation, concept selection, competitive benchmarking, and the establishment of product specifications. The customer-needs activity is shown in Exhibit 5-2 in relation to these other front-end product development activities, which collectively can be thought of as the concept development phase.

2.1.2 Development process

The concept development process illustrated in Exhibit 5-2 implies a distinction between customer needs and product specifications. This distinction is subtle but important.

(One blank line before figure)

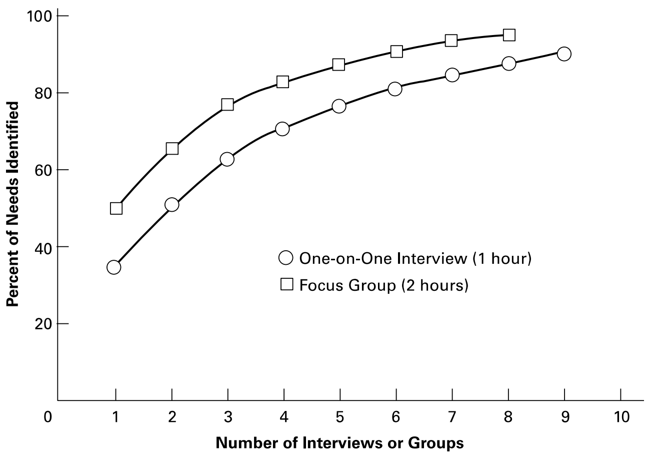

Figure 2-1 Comparison of the percentages of customer needs that are revealed for focus groups and interviews as a function of the number of sessions

批注 [Z. XU2]: The caption of figure be placed under the figure.

(one blank line after figure)

Some practitioners also rely on written surveys for gathering raw data. While a Web-based survey is quite useful later in the process, we cannot recommend this approach for initial efforts to identify customer needs; text-based surveys simply do not provide enough information about the use environment of the product, and they are generally in- effective in revealing unanticipated needs.

(one blank line before table)

Table 2-1 Range of variables in design of experiment

批注 [Z. XU3]: Table caption placed above.

Variable	Minimum	Maximum
Mean rpm(r/min)	1300	2300
Base fuel mass(mg/stroke)	33	127
Egragl(°)	0	90
Soi(°)	0	12

(one blank line after table)

Research by Griffin and Hauser shows that one 2-hour focus group reveals about the same number of needs as two 1-hour interviews (Griffin and Hauser, 1993). (See Exhibit 5-4.) Because interviews are usually less costly (per hour) than focus groups and because an interview often allows the product development team to experience the use environment of the product, we recommend that interviews be the primary data collection method. Interviews may be supplemented with one or two focus groups as a way to allow top management to observe a group of customers or as a mechanism for sharing a common customer experience (via video) with the members of a larger team. Some practitioners believe that for certain products and customer groups, the interactions among the participants of focus groups can elicit more varied needs than are revealed through interviews, although this belief is not strongly supported by research findings.

Chapter 3 Engineering Design

Although engineering drawing still plays an important role in product design and manufacturing in many industrial sectors around the world, manual sketching for creating drawings has been gradually replaced by CAD (computer-aided design) software using computers. Beginning in the 1980s, CAD software reduced the need for draftsmen significantly, especially in small to mid-sized companies. The software's affordability and ability to run on personal computers in the mid-1990s allowed engineers to do their own drafting and analytic work to some extent.

In fact, instead of just creating drawings, CAD has fundamentally changed the way design is done. As in the manual drafting of technical and engineering drawings, the output of CAD conveys information, such as materials, processes, dimensions, and tolerances, according to application-specific conventions in solid models. Instead of drafting in digital form, designers use CAD to create product models in solid model forms with adequate product data, then they create drafting if necessary. CAD solid models offer flexibility and efficiency when making design changes; provide geometric and physical data that support product performance evaluations using computer-aided engineering (CAE); support virtual manufacturing, prototyping, manufacturing process planning, and product cost estimating; and offer product life cycle and product knowledge repository for archiving. Most important, product model in CAD serves as the centerpiece for e-Design.

$$y_i = \beta_0 + x_{i1}\beta_1 + \cdots + x_{i,p-1}\beta_{p-1} + e_i \qquad (3\text{-}1)$$

批注 [Z. XU4]: Number of equations aligned to right

$$y_i = f\left(I_i\right) \qquad (3\text{-}2)$$

$$I_i = \sum_{j=1}^{n} w_{ji} x_j - \theta_i \qquad (3\text{-}3)$$

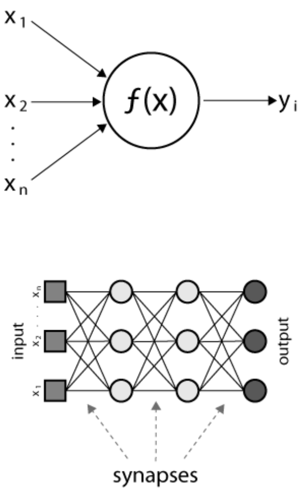

Figure 3-1 The structure of neutral network

Conclusions

During the 1980s, design-for-manufacturing practices were put into place in thousands of firms. Today DFM is an essential part of almost every product development effort. No longer can designers “throw the design over the wall” to production engineers. As a result of this emphasis on improved design quality, some manufacturers claim to have reduced production costs of products by up to 50 percent. In fact, comparing current new product designs with earlier generations, one can usually identify fewer parts in the new product, as well as new materials, more integrated and custom parts, higher-volume standard parts and subassemblies, and simpler assembly procedures.

References

[1] 袁庆龙，候文义．Ni-P 合金镀层组织形貌及显微硬度研究［J］．XX 理工大学学报，2001，32(1)：51-53.

[2] 刘国钧，郑如斯．中国书的故事［MM］．北京：中国青年出版社，1979．80-115．

[3] 孙品一．高校学报编辑工作现代化特征［A］．见：张为民编．中国高等学校自然科学学报研究会．科技编辑学论文集(2)[C]．北京：北京师范大学出版社，1998．10-22．

[4] 罗云．安全科学理论体系的发展及趋势探讨[A]．见：白春华，何学秋，吴宗之．21 世纪安全科学与技术的发展趋势[M]．北京：科学出版社，2000．1-5．

[5] 张和生．嵌入式单片机系统设计［D］．北京：北京理工大学，1998．

[6] 冯西桥．核反应堆压力容器的 LBB 分析［R］．北京：清华大学核能技术设计研究院，1997．

[7] 姜锡洲．一种温热外敷药制备方案［P］．中国专利：881056078，1983-08-12．

[8] GB/T 16159—1996．汉语拼音正词法基本规则［S］．北京：中国标准出版社，1996．

[9] 姚伯元．毕业设计(论文)规范化管理与培养学生综合素质［EB/OL］．中国高等教育网教学研究，2005-2-2．

Appendices

Appendix A Design Structure Matrix Example

One of the most useful applications of the design structure matrix (DSM) method is to represent well-established, but complex, engineering design processes. This rich process modeling approach facilitates:

• Understanding of the existing development process.

• Communication of the process to the people involved.

• Process improvement.

• Visualization of progress during the project.

Exhibit 18-14 shows a DSM model of a critical portion of the development process at a major automobile manufacturer. The model includes 50 tasks involved in the digital mock-up (DMU) process for the layout of all of the many components in the engine compartment of the vehicle. The process takes place in six phases, depicted by the blocks of activities along the diagonal. The first two of these phases (project planning and CAD data collection) occur in parallel, followed by the development of the digital assembly model (DMU preparation). Each of the last three phases involves successively more ac- curate analytical verification that components represented by the digital assembly model actually fit properly within the engine compartment area of the vehicle.

In contrast to the simpler DSM model shown in Exhibit 18-3, where the squares on the diagonal identify sets of coupled activities, the DSM in Exhibit 18-14 uses such blocks to show which activities are executed together (in parallel, sequentially, and/or iteratively) within each phase. Arrows and dashed lines represent the major iterations between sets of activities within each phase.

Acknowledgement

This book contains material developed for use in the interdisciplinary courses on product development that we teach. Participants in these courses include graduate students in engineering, industrial design students, and MBA students. While we aimed the book at interdisciplinary graduate-level audiences such as this, many faculty teaching graduate and undergraduate courses in engineering design have also found the material useful. Product Design and Development is also for practicing professionals. Indeed, we could not avoid writing for a professional audience, because most of our students are themselves professionals who have worked either in product development or in closely related functions.

This book blends the perspectives of marketing, design, and manufacturing into a single approach to product development. As a result, we provide students of all kinds with an appreciation for the realities of industrial practice and for the complex and essential roles played by the various members of product development teams. For industrial practitioners, in particular, we provide a set of product development methods that can be put into immediate practice on development projects.