JK LAKSHMIPAT UNIVERSITY
Institute of Design
NAAC 'A' Grade Accredited

Textbook Design

Engineering course transformed into visually rich textbook.

VOL. 1 of 2

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Sponsor : **Explorra School Of Design**

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Programme :
Bachelor of Design (B.Des)
Interdisciplinary Design

THE GRADUATION PROJECT 2024

The Evaluation Jury has recommended Student Full Name

for graduation from Institute of Design, JK LAKSHMIPAT UNIVERSITY

with specialization in Specialisation name

Herewith, for the project titled “Full Title with Subtitle”

on fulfillment of requirements by

Jury Chairman

Jury Member

Jury Member

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PREFACE

As a design student, my journey has been a blend of creativity, strategy, and learning how to communicate ideas effectively through visuals. Throughout my studies, I've had the opportunity to work on brand building, create designs for social media, and dive into the world of design thinking. These experiences have shaped my understanding of how powerful design can be in making complex information more accessible and engaging.

This textbook for engineers is the culmination of what I've learned. My goal was to take the principles of design—clarity, consistency, and visual appeal—and apply them to a subject that is often seen as technical and difficult. Engineering concepts are challenging, but with the right design, they can be presented in a way that is easier to understand and more enjoyable to learn.

ACKNOWLEDGMENT

I am deeply grateful for offering me the invaluable opportunity to pursue Graphic Design internship at Explorra School of Design and Technology. This journey has equipped me with profound knowledge and insights into the field of Graphic Design.

During my practical experience, I had the privilege of being mentored by Mr. Rohit Swarup. I am genuinely thankful for his guidance and mentorship, which provided me with valuable exposure to the practical aspects of the corporate world. Additionally, I would like to express my appreciation to Ms. Mili Jain for her patient guidance and hands-on learning experience while mentoring me with my Graduation Project.

Lastly, I would like to extend my deepest gratitude to my college faculty member, Yash Raizada. His constant support and invaluable assistance with research have been crucial in shaping this project. Yash's guidance and insights provided a strong foundation, helping me navigate through complex aspects and ensuring the project's success. I am deeply grateful for his encouragement and the expertise he generously shared with me throughout this journey.

Engineering course transformed into visually rich textbook.

The engineering course was fully converted into a textbook format, featuring 11 chapters. The content was meticulously designed and presented in a visually rich format to enhance readability and engagement.

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JK Lakshmipat University

Founded in 2011, JKLU draws inspiration from the visionary foresight of Lala Lakshmipat Singhania, the esteemed founder of the Lakshmipat Singhania Education Foundation.

The Institute of Design at JKLU embodies this ethos by pushing the boundaries of conventional design education. Its focus is on adopting a future-ready, transformative approach that equips students with the skills and mindset needed to thrive in the evolving landscape of design.



Institute of Design

The Institute of Design at JK Lakshmipat University in Jaipur is a premier institution renowned for its excellence in design education. With cutting-edge programs and state-of-the-art facilities, it provides a nurturing environment where aspiring designers can unleash their creativity and hone their skills.

A standout feature of the institute is its comprehensive curriculum, encompassing disciplines such as product design, interaction design, and interdisciplinary design. This multidisciplinary approach enables students to explore diverse aspects of design, fostering innovative thinking and encouraging them to push the boundaries of creativity.



About Me

As an interdisciplinary design student at JK Lakshmipat University, my journey in the field of design has been both enriching and transformative. Having completed my schooling at India International School in Jaipur—a city renowned for its cultural heritage and architectural beauty—I have always been inspired by the vibrant artistic traditions around me.

During my time at JKLU, I have explored a wide range of design disciplines, which has allowed me to discover my passion for graphic design. Through my studies, I have not only acquired new skills but also learned how to create designs that are both impactful and meaningful. This experience has fueled my desire to continue evolving as a designer, constantly pushing the boundaries of creativity and innovation.



Sponsor

The company that I had the privilege of working at as an intern was Explorra School of Design and Technology. Explorra School of Design and Technology is one of the leading institutes in India, offering courses related to Digital Design, Animation, 3D Animation, UX UI, VFX, and Motion Graphics, since its inception in 1999. It works to provide pathway programs to graduates and post-graduates. The degrees offered are both International and National Bachelor's Degree and both UG and PG Diploma Courses.

They have also been partners with universities and colleges in the UK, Canada, Malaysia, and others for digital media design, creative multimedia technology, and emerging technologies. It also focuses on employment related diploma and certificate courses.

The organization has received various accolades, amongst which is the "Shiksha Bharti Puraskar" and "Indian Leadership Award for Education Excellence" in regards to their 100% placement record and also, the industry-best 21st Century Curriculum and Teaching Practices employed by them.

Project Brief

In the initial days of my role, my primary focus was on familiarizing myself with the company culture, understanding its vision, and aligning with its philosophy. Once I had a strong grasp of these foundational elements, I began working on a significant project—transforming an engineering course into a textbook.

This involved meticulously organizing the course content into a well-structured format, ensuring each chapter effectively conveyed the essential topics. My task extended beyond just organizing; I was responsible for designing the textbook to be visually engaging. By incorporating rich graphics, diagrams, and infographics, I aimed to make complex engineering concepts more accessible and appealing to students, resulting in a textbook that is both informative and visually compelling.

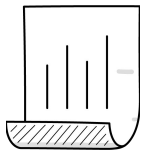
Research and Analysis

Objective

The objective of this project was to take an existing engineering course and transform it into a comprehensive and visually engaging textbook. The aim was to organize the course content into a structured, user-friendly format that enhances learning through a rich array of visual elements. This approach sought to make complex engineering concepts more accessible and understandable by integrating diagrams, illustrations, and infographics throughout the text. Ultimately, the project aimed to create a textbook that not only conveys technical information effectively but also improves student engagement and retention, providing a modern, visually appealing resource for engineering education.

My Design Process

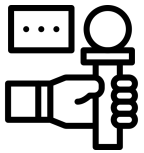
Analyzing the Brief



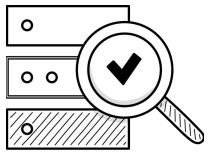
Research



Interviews



Analysis



Brainstorm



Ideate



Literature Review

Background Research

In researching existing engineering textbooks, several key strengths and weaknesses became evident, particularly in terms of design, layout, and educational effectiveness. On the positive side, most textbooks offer comprehensive coverage of topics, providing in-depth theoretical knowledge and serving as reliable reference materials for students. Their structured layout, with clear headings, subheadings, and highlighted formulas, helps guide readers through the content in a systematic way. Additionally, some textbooks successfully combine theory with practical applications, providing example problems to reinforce understanding.

However, these textbooks also display significant weaknesses, particularly in their design and engagement with students. Many rely too heavily on dense text and formulas, which can overwhelm readers and diminish interest. The lack of visual aids, such as infographics and illustrative diagrams, further limits students' ability to engage with the material. Moreover, most textbooks do not provide enough real-world context, making it difficult for students to connect abstract concepts with practical applications, which can reduce their motivation to learn. The graphics used are often outdated or inconsistent, resulting in a less cohesive and visually appealing experience. Additionally, the absence of interactive elements, such as quizzes or exercises, reflects an outdated design approach, failing to meet the expectations of modern learners who often look for dynamic, digital content.

Goals

The primary goal of creating a design thinking book for engineering students is to introduce them to the fundamental concepts and methodologies of design thinking, bridging the gap between technical problem-solving and creative innovation. This book aims to familiarize students with the design thinking process, which includes empathy, defining problems, ideating solutions, prototyping, and testing, all within the context of engineering. By encouraging a user-centric approach, the book will shift students' focus from purely technical solutions to ones that prioritize the needs and experiences of end users, making their work more relevant and impactful.

Another essential goal is to foster creativity and innovation in engineering students. Traditional engineering education often emphasizes analytical thinking, but this book will highlight the importance of ideation and prototyping, helping students to develop more original and practical solutions. Additionally, it will aim to cultivate interdisciplinary collaboration skills, teaching students how to work effectively with professionals from other fields, such as design and business. Ultimately, this book will equip engineering students with the tools needed to solve complex, real-world problems in a holistic, innovative, and user-friendly manner.

Effective Teaching Mehtods

Engineering colleges utilize a range of pedagogies to effectively teach complex concepts and prepare students for professional challenges. Traditional lectures are complemented by active learning techniques like Problem-Based Learning (PBL) and collaborative projects, which engage students in real-world problem-solving. Experiential learning through labs and fieldwork, along with technology-enhanced methods like e-learning and virtual simulations, provide practical experience. The flipped classroom model promotes interactive application of knowledge, while case-based teaching and inquiry-based learning foster deep understanding and critical thinking. Industry integration through internships and guest lectures bridges the gap between theory and practice, creating a dynamic and effective learning environment.

Learning Methods

Engineering colleges use diverse learning pedagogies to enhance student understanding and application of engineering principles. Key approaches include active learning techniques like Problem-Based Learning (PBL) and collaborative projects, which involve real-world problem-solving and teamwork. Experiential learning through labs, workshops, and fieldwork provides practical experience, while project-based learning integrates knowledge into comprehensive projects and design challenges. The flipped classroom model encourages pre-class study and interactive in-class application, and inquiry-based learning fosters independent research and critical thinking. Technology-enhanced methods, such as e-learning platforms and virtual simulations, support traditional teaching.

Integrated learning combines various engineering disciplines, while competency-based and case-based approaches focus on skill development and real-world scenarios. Feedback-oriented learning ensures continuous improvement and assessment of student knowledge.

Latest trends

- Interactive Elements: Add quizzes and simulations for engagement.
- Augmented Reality (AR): Use AR to display 3D models and enhance learning.
- Visual Learning Tools: Include high-quality graphics and infographics
- Modular Content: Design flexible, navigable sections.
- Case Studies: Integrate real-world examples to connect theory with practice.
- Digital Integration: Offer interactive digital versions with multimedia content.
- Collaborative Tools: Support group activities and discussions.
- Adaptive Learning: Incorporate tech that adjusts content based on student needs.
- AI and Data Analytics: Use AI for personalized feedback and data insights.

Engineering Colleges (Top)

Indian Institute of Technology (IIT) Bombay

Teaching Methodology: IIT Bombay employs a blend of traditional lectures and interactive, project-based learning. The teaching approach often includes case studies, research projects, and hands-on experiments.

Learning Focus: Emphasis is placed on interdisciplinary learning and innovation. Students are encouraged to work on real-world problems, participate in research initiatives, and engage with industry through internships and collaborative projects.

Indian Institute of Technology (IIT) Delhi

Teaching Methodology: IIT Delhi integrates rigorous theoretical instruction with practical applications. The use of modern pedagogical tools, including digital simulations and interactive labs, is prevalent.

Learning Focus: The focus is on deep theoretical understanding combined with practical problem-solving. Students often work on cutting-edge research and industry-sponsored projects, enhancing their problem-solving skills.

Indian Institute of Technology (IIT) Kanpur

Teaching Methodology: IIT Kanpur emphasizes experimental learning through well-equipped laboratories and workshops. Their teaching includes a mix of lectures, tutorials, and hands-on projects.

Learning Focus: The institute promotes learning through research and practical experiences. Students have the opportunity to work on significant research projects and engage with emerging technologies.

Indian Institute of Technology (IIT) Madras

Teaching Methodology: IIT Madras uses a combination of classroom lectures, interactive sessions, and fieldwork. The institute incorporates digital tools and simulations into their teaching practices.

Learning Focus: There is a strong emphasis on integrating industry practices and real-world applications into the curriculum. Students are involved in projects and research that address practical engineering challenges.

Indian Institute of Technology (IIT) Kharagpur

Teaching Methodology: IIT Kharagpur utilizes a diverse range of teaching methods, including lectures, labs, and fieldwork. The institute encourages collaborative learning through group projects and peer interactions.

Learning Focus: The focus is on a comprehensive understanding of engineering principles, with significant emphasis on practical applications and industry collaboration.

Indian Institute of Technology (IIT) Hyderabad

Teaching Methodology: IIT Hyderabad combines lectures with a strong emphasis on project-based learning and research. The institute uses modern teaching tools and encourages active student participation.

Learning Focus: Emphasis is placed on innovation and emerging technologies. Students are encouraged to work on interdisciplinary projects and engage in cutting-edge research.

National Institute of Technology (NIT) Trichy

Teaching Methodology: NIT Trichy follows a balanced approach with a focus on both theoretical instruction and practical application. Interactive teaching methods, including problem-solving sessions and lab work, are used.

Learning Focus: The learning environment promotes hands-on experience and industry interaction. Students often work on real-world problems and engage with industry professionals through internships and projects.

National Institute of Technology (NIT) Surathkal

Teaching Methodology: IIT Hyderabad combines lectures with a strong emphasis on project-based learning and research. The institute uses modern teaching tools and encourages active student participation.

Learning Focus: Emphasis is placed on innovation and emerging technologies. Students are encouraged to work on interdisciplinary projects and engage in cutting-edge research.

Indian Institute of Technology (IIT) Guwahati

Teaching Methodology: IIT Guwahati employs a combination of lectures, interactive sessions, and laboratory work. The institute integrates research activities into the learning process.

Learning Focus: The focus is on innovative and sustainable engineering solutions. Students are encouraged to participate in research and work on projects that address contemporary engineering challenges.

Indian Institute of Technology (IIT) Ropar

Teaching Methodology: IIT Ropar uses a diverse range of teaching methods, including lectures, lab work, and collaborative projects. The institute emphasizes the use of modern technology in education.

Learning Focus: There is a strong emphasis on practical applications and research. Students are encouraged to work on innovative projects and engage in industry-relevant research

Comparison

Top Colleges

In top colleges, the pedagogical approach is research-driven, interdisciplinary, and industry-focused, providing students with a global perspective, advanced technology, and strong alumni support. These institutions promote innovation, critical thinking, and problem-solving through projects, modern tools, and industry collaboration.

Normal Colleges

In contrast, normal colleges often rely on traditional teaching methods, with fewer opportunities for research, innovation, and global exposure. The infrastructure, faculty, and industry connections may be more limited, which can restrict students' access to cutting-edge technologies and high-quality internships or placements.

Iterative Process in Pedagogy

Problem Identification

Students are introduced to a problem or design challenge. They analyze the requirements and constraints, just as engineers do in real-world projects.

Research and Ideation

Students conduct research, brainstorm ideas, and develop preliminary concepts. Instructors may encourage them to explore multiple solutions or approaches to a single problem.

Prototype/Concept Development

The first version of the solution is created, whether it’s a physical prototype, a software program, or a conceptual design. At this stage, students apply their technical skills to turn their ideas into tangible outcomes.

Testing and Evaluation

The prototype or solution is tested against the problem's requirements. This could involve simulations, experiments, or peer evaluations, helping students gather data on how well their design performs.

Feedback and Analysis

Based on test results, feedback is gathered. Students analyze the shortcomings or areas where the solution can be improved. This phase often involves critical thinking and problem-solving skills as they identify what went wrong or how to optimize performance.

Refinement

The solution is revised based on the feedback and new insights. This is the "iterative" part, where students cycle back to earlier stages to adjust their design, improve its effectiveness, or make it more efficient.

Repeat the Process

This cycle continues, often multiple times, until an optimal solution is achieved. Each iteration brings students closer to a refined and effective outcome, and they learn to approach problems as dynamic and evolving, rather than static.

Cognitive Load

Cognitive Load Theory helps optimize learning by managing mental effort. By balancing intrinsic, germane, and extraneous loads, educators can enhance student outcomes. AI-enriched digital textbooks, which link concepts and provide interactive questions, increase germane load for deeper learning. Pre-lecture e-resources reduce load during lectures, making complex topics easier to grasp. Interactive lectures and well-designed instructional materials (text + visuals) lower extraneous load, improving retention. Tools that break down complex tasks, like modeling diagrams, enhance understanding.

Managing Cognitive Load

Simplify Concepts

- Break down the design thinking process into small, clear sections with step-by-step explanations.

Use Visuals

- Incorporate diagrams and flowcharts to illustrate each phase, making abstract ideas more tangible.

Emphasize Key Points

- Highlight essential stages and tools with bold or color to guide focus.

Interactive Learning

- Include exercises and real-world design challenges that gradually increase in complexity.

Align Text and Visuals

- Place explanations close to diagrams, reducing the need to switch between text and images.

Minimize Distractions

- Avoid unnecessary information and keep visuals functional, not decorative.

Real-World Examples

- Use case studies that show how design thinking is applied in engineering projects.

Encourage Reflection

- Add reflection questions and formative assessments to reinforce learning.

Competitors

Design Thinking: Integrating Innovation, Customer Experience, and Brand Value by Thomas Lockwood

Overview: This book provides a comprehensive introduction to design thinking, focusing on how it can be integrated into engineering projects to enhance innovation and customer experience.

Strengths: Accessible language, practical examples relevant to engineering students, and a focus on the real-world application of design thinking in engineering contexts.

Weaknesses: The content is broad, covering multiple disciplines, which might dilute its focus on pure engineering challenges.

Design Thinking for Engineers and Scientists by Nigel Cross

Overview: This book offers a practical guide to design thinking tailored specifically for engineering and science students. It emphasizes problem-solving and creativity in engineering design processes.

Strengths: Targeted directly at engineering students, with a clear focus on how to apply design thinking in technical fields. Includes case studies and exercises.

Weaknesses: The content might be too basic for advanced students or professionals looking for more in-depth analysis.

Engineering Design: A Systematic Approach by G. Pahl, W. Beitz, and J. Feldhusen

Overview: Although not purely a design thinking book, this classic text integrates systematic engineering design with design thinking principles. It's a valuable resource for students looking to apply structured methodologies in their work.

Strengths: Comprehensive coverage of engineering design processes, with an emphasis on applying design thinking principles systematically.

Weaknesses: Dense and technical, more suitable for students with a strong engineering background.

Creative Confidence: Unleashing the Creative Potential Within Us All by Tom Kelley and David Kelley

Overview: Written by the founders of IDEO, this book is a motivational guide to unlocking creativity using design thinking, tailored for students and young professionals.

Strengths: Inspiring and accessible, with practical advice on fostering creativity in engineering contexts. Includes real-life examples from the engineering field.

Weaknesses: More of a motivational and general guide rather than a technical manual, which might be less appealing to students looking for more rigorous engineering content.

Analysis

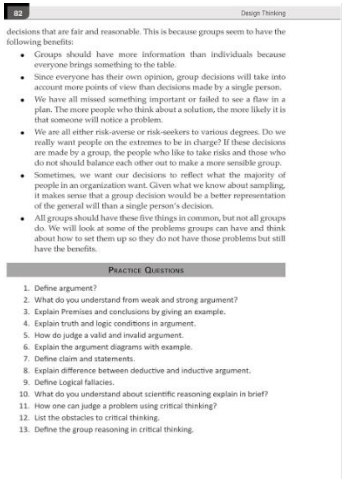
Typography: "The Design of Everyday Things" and "Creative Confidence" stand out for their modern, sans-serif typography, which enhances readability and engagement. "Design Thinking for Engineers and Scientists" uses a more traditional serif font, which suits its academic tone, while "Engineering Design: A Systematic Approach" also uses traditional typography but can be dense.

Layout: "Creative Confidence" and "The Design of Everyday Things" have the most engaging layouts, with interactive elements that make reading enjoyable. "Design Thinking for Engineers and Scientists" has a functional layout, focusing on content delivery, while "Engineering Design: A Systematic Approach" is dense but systematic

Content Organization: "Design Thinking for Engineers and Scientists" is highly structured and ideal for methodical learning. "Creative Confidence" and "The Design of Everyday Things" are more narrative-driven, which can be more engaging but less structured. "Engineering Design: A Systematic Approach" is very systematic but might be challenging due to its density.

Visual Design: "Creative Confidence" excels in visual appeal, with a vibrant and inviting design. "The Design of Everyday Things" also has a strong visual identity, while "Design Thinking for Engineers and Scientists" and "Engineering Design: A Systematic Approach" focus more on content clarity than on visual appeal.

Different Engineering books



82 Design Thinking

decisions that are fair and reasonable. This is because groups seem to have the following benefits:

- Groups should have more information than individuals because everyone brings something to the table.
- Since everyone has their own opinion, group decisions will take into account more points of view than decisions made by a single person.
- We have all missed something important or failed to see a flaw in a plan. The more people who think about a solution, the more likely it is that someone will notice a problem.
- We are all either risk-averse or risk-seekers to various degrees. Do we really want people on the extremes to be in charge? If these decisions are made by a group, the people who like to take risks and those who do not should balance each other out to make a more sensible group.
- Sometimes, we want our decisions to reflect what the majority of people in an organization want. Given what we know about sampling, it makes sense that a group decision would be a better representation of the general will than a single person's decision.
- All groups should have these five things in common, but not all groups do. We will look at some of the problems groups can have and think about how to set them up so they do not have those problems but still have the benefits.

Practice Questions

1. Define argument?
2. What do you understand from weak and strong argument?
3. Explain Premises and conclusions by giving an example.
4. Explain truth and logic conditions in argument.
5. How do judge a valid and invalid argument.
6. Explain the argument diagrams with example.
7. Define claim and statements.
8. Explain difference between deductive and inductive argument.
9. Define Logical fallacies.
10. What do you understand about scientific reasoning explain in brief?
11. How one can judge a problem using critical thinking?
12. List the obstacles to critical thinking.
13. Define the group reasoning in critical thinking.



Chapter 1

Design Thinking and Its Principles

1.1. DESIGN THINKING

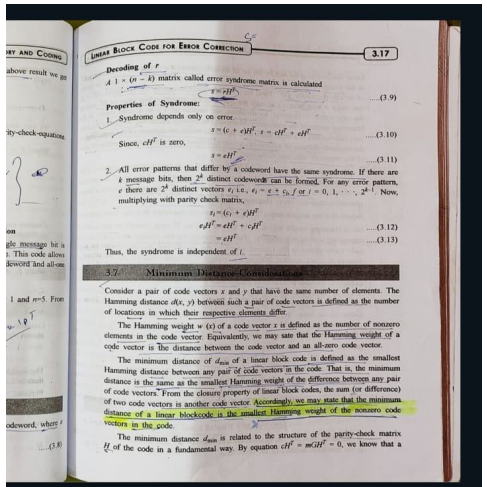
- Design thinking is a way to find simplicity in complexity, improve the quality of how people use the products that are designed, and meet the needs of customers by solving the problem they are trying to solve. Design thinking is at the heart of making strategies for organizational change that work well and are efficient.
- Design thinking is a way for designers to come up with ideas and solve hard problems in designing and design engineering. Designers can also help customers and clients by coming up with new, interesting, and never-thought-of-before solutions.
- The iterative design process helps designers find meaningful ways to involve clients and customers. It is not just a way to come up with possible solutions to a problem; it is also a way to come up with solutions you never would have thought of and then try to make them not only possible but also viable.
- Design thinking is used a lot in health and wellness, agriculture, food security, education, financial services, and environmental sustainability, to name a few. Design thinking has helped in the digital space, led to the creation of physical products, sparked social innovation projects, and done a lot more.

1.1.1. Features of Design Thinking

Design thinking helps in multidimensional solutions. It helps professional to find a solution and gives a business a competitive edge. Design thinking has several benefits. Some basic features for using design thinking:

(a) Discovering the simplicity hidden among the complications.

1



Linear Block Code for Error Correction 3.17

Decoding of r

$A\ 1 \times (n-k)$ matrix called error syndrome matrix is calculated

$$s = yH^T \quad \ldots(3.9)$$

Properties of Syndrome:

1. Syndrome depends only on error.

$$s = (c_i + e)H^T, \; s = cH^T + eH^T \quad \ldots(3.10)$$

Since, cH^T is zero,

$$s = eH^T \quad \ldots(3.11)$$

2. All error patterns that differ by a codeword have the same syndrome. If there are k message bits, then 2^k distinct codewords can be formed. For any error pattern, e there are 2^k distinct vectors e_i i.e., $e_i = e + c_i$ for $i = 0, 1, \cdots, 2^k - 1$. Now, multiplying with parity check matrix,

$$s_i = (c_i + e)H^T$$
$$e_iH^T = eH^T + c_iH^T \quad \ldots(3.12)$$
$$= eH^T \quad \ldots(3.13)$$

Thus, the syndrome is independent of i.

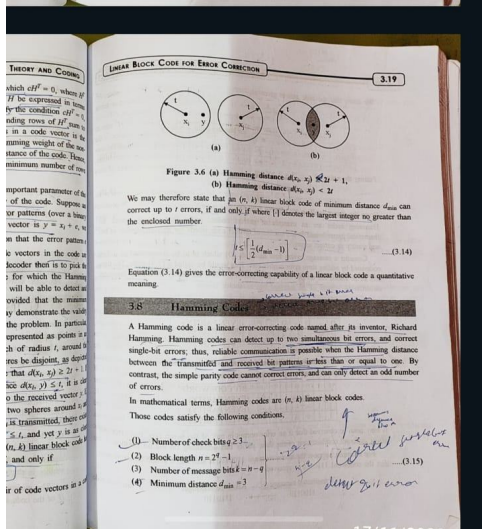
3.7 Minimum Distance Considerations

Consider a pair of code vectors x and y that have the same number of elements. The Hamming distance $d(x, y)$ between such a pair of code vectors is defined as the number of locations in which their respective elements differ.

The Hamming weight $w(x)$ of a code vector x is defined as the number of nonzero elements in the code vector. Equivalently, we may sate that the Hamming weight of a code vector is the distance between the code vector and an all-zero code vector.

The minimum distance of d_{min} of a linear block code is defined as the smallest Hamming distance between any pair of code vectors in the code. That is, the minimum distance is the same as the smallest Hamming weight of the difference between any pair of code vectors. From the closure property of linear block codes, the sum (or difference) of two code vectors is another code vector. Accordingly, we may state that the minimum distance of a linear blockcode is the smallest Hamming weight of the nonzero code vectors in the code.

The minimum distance d_{min} is related to the structure of the parity-check matrix H of the code in a fundamental way. By equation $cH^T = mGH^T = 0$, we know that a



Linear Block Code for Error Correction 3.19

(a) (b)

Figure 3.6 (a) Hamming distance $d(x_i, x_j) \geq 2t + 1$, (b) Hamming distance $d(x_i, x_j) < 2t$

We may therefore state that an (n, k) linear block code of minimum distance d_{min} can correct up to t errors, if and only if where $\lfloor \cdot \rfloor$ denotes the largest integer no greater than the enclosed number.

$$t \leq \left\lfloor \frac{1}{2}(d_{min} - 1) \right\rfloor \quad \ldots(3.14)$$

Equation (3.14) gives the error-correcting capability of a linear block code a quantitative meaning.

3.8 Hamming Codes

A Hamming code is a linear error-correcting code named after its inventor, Richard Hamming. Hamming codes can detect up to two simultaneous bit errors, and correct single-bit errors; thus, reliable communication is possible when the Hamming distance between the transmitted and received bit patterns is less than or equal to one. By contrast, the simple parity code cannot correct errors, and can only detect an odd number of errors.

In mathematical terms, Hamming codes are (n, k) linear block codes.

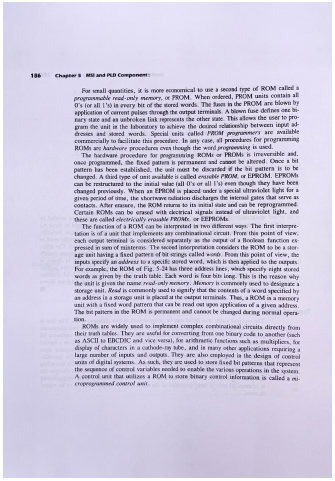
Those codes satisfy the following conditions.

(1) Number of check bits $q \geq 3$

(2) Block length $n = 2^q - 1$

(3) Number of message bits $k = n - q$ ...(3.15)

(4) Minimum distance $d_{min} = 3$



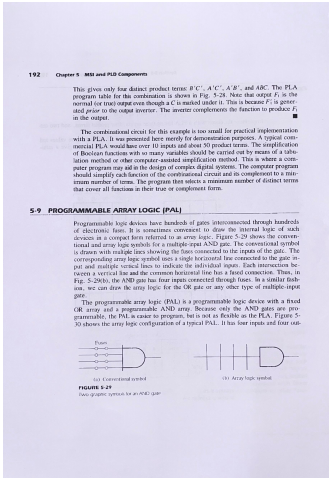
186 Chapter 5 MSI and PLD Components

For small quantities, it is more economical to use a second type of ROM called a *programmable read-only memory*, or PROM. When ordered, PROM units contain all 0's (or all 1's) in every bit of the stored words. The fuses in the PROM are blown by application of current pulses through the output terminals. A blown fuse defines one binary state and an unbroken link represents the other state. This allows the user to program the unit in the laboratory to achieve the desired relationship between input addresses and stored words. Special units called *PROM programmers* are available commercially to facilitate this procedure. In any case, all procedures for programming ROMs are *hardware* procedures even though the word *programming* is used.

The hardware procedure for programming ROMs or PROMs is irreversible and, once programmed, the fixed pattern is permanent and cannot be altered. Once a bit pattern has been established, the unit must be discarded if the bit pattern is to be changed. A third type of unit available is called *erasable PROM*, or EPROM. EPROMs can be restructured to the initial value (all 0's or all 1's) even though they have been changed previously. When an EPROM is placed under a special ultraviolet light for a given period of time, the shortwave radiation discharges the internal gates that serve as contacts. After erasure, the ROM returns to its initial state and can be reprogrammed. Certain ROMs can be erased with electrical signals instead of ultraviolet light, and these are called *electrically erasable PROMs*, or EEPROMs.

The function of a ROM can be interpreted in two different ways. The first interpretation is of a unit that implements any combinational circuit. From this point of view, each output terminal is considered separately as the output of a Boolean function expressed in sum of minterms. The second interpretation considers the ROM to be a storage unit having a fixed pattern of bit strings called *words*. From this point of view, the inputs specify an *address* to a specific stored word, which is then applied to the outputs. For example, the ROM of Fig. 5-24 has three address lines, which specify eight stored words as given by the truth table. Each word is four bits long. This is the reason why the unit is given the name *read-only memory*. *Memory* is commonly used to designate a storage unit. *Read* is commonly used to signify that the contents of a word specified by an address in a storage unit is placed at the output terminals. Thus, a ROM is a memory unit with a fixed word pattern that can be read out upon application of a given address. The bit pattern in the ROM is permanent and cannot be changed during normal operation.

ROMs are widely used to implement complex combinational circuits directly from their truth tables. They are useful for converting from one binary code to another (such as ASCII to EBCDIC and vice versa), for arithmetic functions such as multipliers, for display of characters in a cathode-ray tube, and in many other applications requiring a large number of inputs and outputs. They are also employed in the design of control units of digital systems. As such, they are used to store fixed bit patterns that represent the sequence of control variables needed to enable the various operations in the system. A control unit that utilizes a ROM to store binary control information is called a *microprogrammed control unit*.



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This gives only four distinct product terms: $B'C'$, $A'C'$, $A'B'$, and ABC. The PLA program table for this combination is shown in Fig. 5-28. Note that output F_1 is the normal (or true) output even though a C is marked under it. This is because F_1 is generated *prior* to the output inverter. The inverter complements the function to produce F_2 in the output. ■

The combinational circuit for this example is too small for practical implementation with a PLA. It was presented here merely for demonstration purposes. A typical commercial PLA would have over 10 inputs and about 50 product terms. The simplification of Boolean functions with so many variables should be carried out by means of a tabulation method or other computer-assisted simplification method. This is where a computer program may aid in the design of complex digital systems. The computer program should simplify each function of the combinational circuit and its complement to a minimum number of terms. The program then selects a minimum number of distinct terms that cover all functions in their true or complement form.

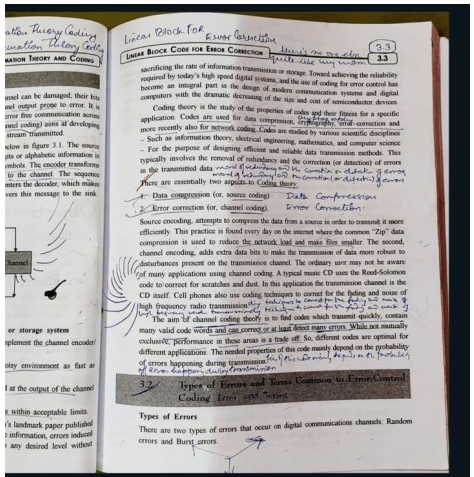
5-9 PROGRAMMABLE ARRAY LOGIC (PAL)

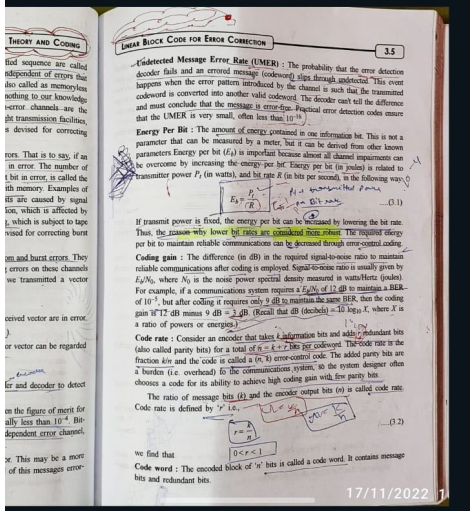
Programmable logic devices have hundreds of gates interconnected through hundreds of electronic fuses. It is sometimes convenient to draw the internal logic of such devices in a compact form referred to as *array logic*. Figure 5-29 shows the conventional and array logic symbols for a multiple-input AND gate. The conventional symbol is drawn with multiple lines showing the lines connected to the inputs of the gate. The corresponding array logic symbol uses a single horizontal line connected to the gate input and multiple vertical lines to indicate the individual inputs. Each intersection represents a vertical line and the common horizontal line has a fixed connection. Thus, in Fig. 5-29(b), the AND gate has four inputs connected through fuses. In a similar fashion, we can draw the array logic for the OR gate or any other type of multiple-input gate.

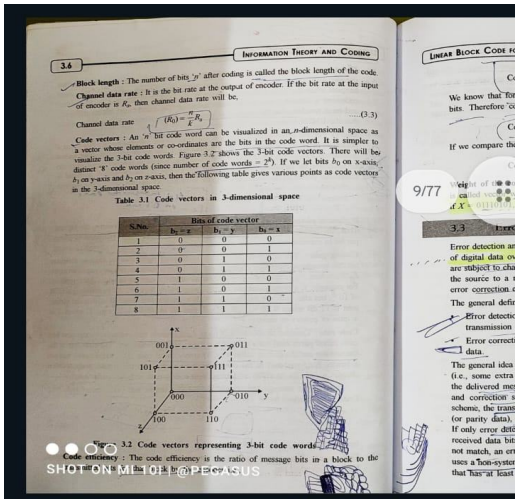
The programmable array logic (PAL) is a programmable logic device with a fixed OR array and a programmable AND array. Because only the AND gates are programmable, the PAL is easier to program, but is not as flexible as the PLA. Figure 5-30 shows the array logic configuration of a typical PAL. It has four inputs and four outputs.

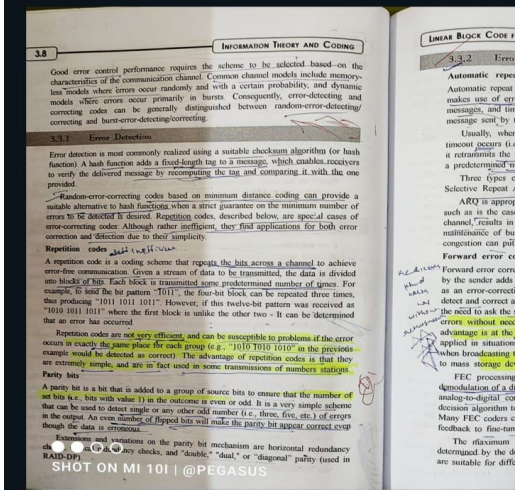
(a) Conventional symbol (b) Array logic symbol

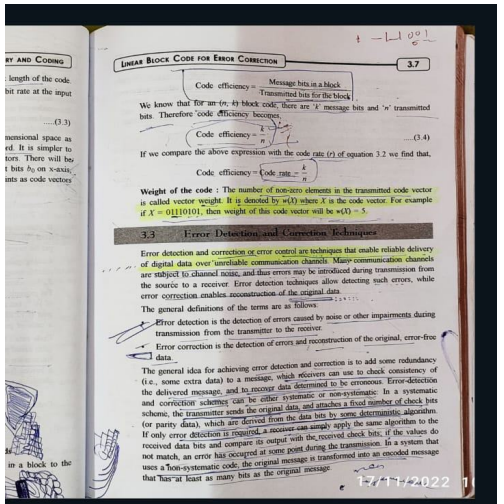
FIGURE 5-29
Two graphic symbols for an AND gate

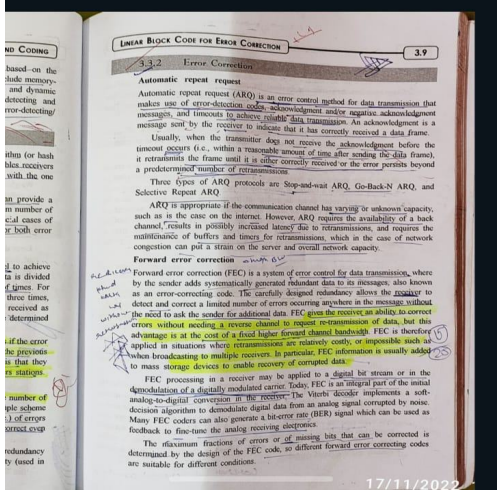












Learning styles

The main types of learning styles are typically categorized into four primary groups, often referred to as the VARK model.

1. Visual Learners

Learn best through seeing. They prefer visual aids such as diagrams, charts, graphs, and pictures.

Characteristics:

- Use of color-coded notes.
- Preference for diagrams over written explanations.
- Benefit from visual presentations and spatial understanding.

2. Auditory Learners

Learn best through listening. They prefer verbal instructions and discussions.

Characteristics:

- Enjoys listening to lectures and podcasts.
- Remembers spoken information well.
- Benefits from discussions, reading aloud, and verbal repetition.

1. Reading/Writing Learners

Learn best through reading and writing. They prefer to interact with text, whether through reading or writing notes.

Characteristics:

- Enjoys reading and taking notes.
- Prefers manuals, reports, essays, and written explanations.
- Benefits from writing summaries, lists, and creating flashcards.

4. Kinesthetic Learners

Learn best through doing and physical engagement. They prefer hands-on experiences and real-world applications.

- Characteristics:
  - Enjoys experiments, fieldwork, and demonstrations.
  - Learns through trial and error and physical activities.
  - Benefits from labs, practical exercises, and simulations.

Target Audience

The target audience for this project includes a broad spectrum of learners and educators, primarily university students enrolled in engineering programs who seek a structured and visually engaging resource to enhance their understanding of complex topics. By incorporating clear explanations, interactive exercises, and visual aids, the textbook and workbook format is tailored to support students in mastering technical concepts more effectively.

Instructors and professors are also a key audience, as the material serves as a reliable and comprehensive teaching tool that streamlines lesson planning and ensures consistency in the delivery of content across institutions. This makes it easier for educators to focus on teaching while providing their students with high-quality, research-based materials.

Universities and colleges offering the course can adopt this textbook and workbook to standardize their curriculum and stay aligned with the latest research and industry developments.

Additionally, libraries and academic centers will find value in this resource as a comprehensive and up-to-date addition to their collections, making it accessible to a wider audience. By addressing the needs of these varied groups, the project ensures that it not only enhances learning but also supports effective teaching, self-study, and continuous professional development.

Primary Research

Questionnaire

This questionnaire is designed to gain insights into how students approach and engage with their studies, particularly in engineering. It covers various aspects such as study routines, preferred methods, and strategies for handling challenges. By understanding these elements, educators can tailor resources and support to better meet students' needs, improve engagement, and enhance learning outcomes.

Questions

1. What is your daily study routine like?
2. How do you typically approach studying?
3. What are your preferred study methods (e.g., textbooks, online resources, study groups, etc.)?
4. How do you stay engaged and interested in your coursework?
5. How do you handle difficult or challenging subjects?
6. What do you enjoy most about your engineering studies?
7. What study techniques do you find most effective ?
8. How do you select which textbooks or resources to use for your courses?
9. What features do you look for in educational materials to make them more engaging and effective?
10. How do real-world examples and case studies influence your understanding of engineering concepts?
11. How do you prioritize different subjects or topics when studying?
12. What aspects of your studies do you find most challenging?
13. What is your approach to preparing for exams?
14. How often do you use online resources like videos or tutorials?
15. What types of materials help you understand complex concepts better?
16. How do you see the concepts you learn in class applying to real-world engineering problems?
17. Can you share an experience where a practical project helped you understand a theoretical concept better?
18. How do you break down complex topics for better understanding?
19. What subjects do you find most interesting and why?
20. How do you approach learning new and unfamiliar concepts?

User 1

A computer science student, focusing on developing software, finds design thinking essential for planning, visualizing ideas, and creating prototypes. She uses online videos and notes for learning, especially appreciating real-world examples during lab sessions. She prefers visual aids like pictures, flowcharts, and tables to grasp concepts easily, and engages more with project-based learning. When faced with difficult questions, she consults faculty or online videos. While theoretical books can be boring, she values books recommended by her teachers. She looks at the front page and index when starting a book, and the use of colors is important to her. During exams, she mainly uses YouTube videos to review concepts.

User 2

A second-year computer science student prefers studying through YouTube videos and class notes, with a stronger preference for online lectures. Instead of textbooks, he uses long PowerPoint presentations that include photos and little text. When unsure about a topic, he checks with friends or turns to YouTube. He finds online articles and websites interesting, and teachers provide reference books, but there are no course books. Case studies are engaging for him, helping him relate and visualize concepts, and he finds them time-saving. Physics isn't his strong point, and he relies on YouTube videos for it. Teaching is mostly lecture-based, using PowerPoint, and there are no books specifically for engineering design thinking.

User 3

A second-year computer science student prefers writing down topics and then watching videos related to those topics. He relies on notes during exams and uses long PowerPoint presentations with photos and minimal text instead of textbooks. If confused, he asks friends, watches YouTube, or skips the topic. He enjoys colorful, animated online lectures and finds articles engaging. Teachers recommend reference books, but there are no course books. He checks the contents and cover of a book to see if it interests him. Case studies are relatable and help him visualize ideas, saving time. He's less involved in physics and uses YouTube for that subject. He appreciates Udemy's format of short lectures followed by exercises, where you must complete one section to move to the next. Teaching is primarily lecture-based using PowerPoint, and design thinking books are often confusing when they contain only text. He enjoys writing down interesting words.

User 4

A mechatronics student mostly studies during exam time, using e-books instead of textbooks due to limited availability in the library. She finds e-books easier to navigate but dislikes needing multiple books for a single topic. Examples keep her engaged, and she prefers easy language with short, clear facts. Sometimes, she misses pages in e-books, and certain subjects feel boring. She watches videos to understand topics and explains them to herself or others for better understanding. Flowcharts help her memorize content, and real-world examples are key for connecting concepts to lab work. She relies heavily on online resources and finds diagrams helpful for simplifying complex topics. How faculty teach also influences her learning, and design thinking is about creating things with detailed examples. Colors and formatting in materials are important to her, making them more attractive.

Analysis / Takeaways

Use of Visual Aids: Include plenty of pictures, flowcharts, tables, and diagrams to make complex concepts easier to understand and save time.

Real-World Examples: Incorporate real-world examples and case studies to help students relate theory to practical applications, making the content more engaging.

E-books and Accessibility: Ensure the textbook is easy to navigate, especially for digital versions, and provide all necessary information in one place to avoid confusion.

Simple Language: Use clear, concise language with short facts to keep students engaged and make the material easy to follow.

Engaging Design: Use colors, consistent formatting, and attractive layouts to capture attention and make the textbook visually appealing.

Tech Integration

Interactive QR Codes

- Purpose: QR codes can provide instant access to supplementary digital resources.

- Integration: Place QR codes throughout the textbook that link to:

    - Video tutorials or animations explaining complex concepts.
    - Case studies, interviews with experts, or real-world project examples.
    - Online exercises, quizzes, and assessments for self-evaluation.

Embedded Multimedia Content

- Purpose: Embedded multimedia adds variety and engages different learning styles.

- Integration:

    - Embed links to videos, audio clips, and podcasts that expand on the topics covered in the text.
    - Include "watch" or "listen" sections that complement the written material, offering alternative explanations, interviews with design thinking practitioners, or real-world case study breakdowns.

Gamification

- Purpose: Gamification elements can make learning more engaging and fun.

- Integration:

    - Introduce game-like challenges or badges within the workbook. Students can "unlock" new exercises or levels after completing certain sections.
    - Include team-based challenges or competitions where students can collaborate on design thinking problems and compete for digital rewards.

Case Studies

Illustrating Real-World Applications

- Use: Incorporate case studies to show how design thinking is applied in real engineering projects.
- Benefit: Helps students understand the relevance of what they're learning and how it can be used to solve real-world challenges.
- Example: A case study on how a company used design thinking to redesign a mechanical product for improved user experience

Breaking Down Complex Concepts

- Use: Case studies can simplify complex ideas by presenting them in the context of an actual problem-solving process.

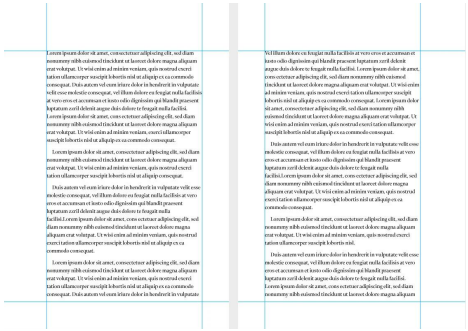
- Benefit: Makes learning easier, especially when students see the step-by-step application of theoretical concepts.

- Example: A case study on the empathy phase of design thinking, showing how engineers gathered user feedback to inform their design decisions.

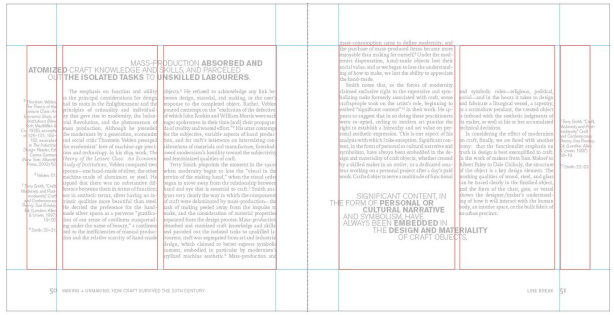
Layout Design

Started by structuring the content modularly with clear headings and subheadings that break down complex topics into manageable sections. Visuals and diagrams are essential in engineering textbooks; they should be placed near relevant text to maintain context and should be clearly labeled. Maintaining a consistent style for all visuals (same color scheme, line thickness, and fonts) adds cohesiveness to the design. Generous white space around text, diagrams, and between sections prevents the layout from looking cluttered, improving readability and making complex concepts less overwhelming.

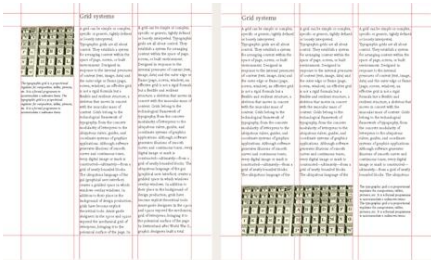
Layout Design



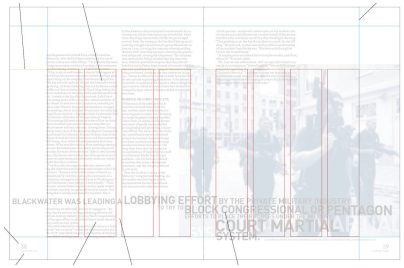
Single-column Grid



Two-column Grid



Multicolumn Grids



four-column Grids



Modular Grids

Inclusive Material

Inclusive textbook design incorporates diverse representation, accessible content, and varied learning approaches to cater to a wide range of students. It includes diversity in examples and images, ensures accessibility through readable fonts, alt text, and multiple formats, and provides differentiated learning activities for various learning styles. Interactive media and flexible navigation options enhance engagement, while real-world, and case studies promote inclusion and readability for all learners.

Structure

Cover Page
Table of Contents
Introduction
Chapter Structure
Chapter Title
Content
Body

Online Platform

Interactive Content:

- Multimedia Integration: Embed videos, animations, and interactive diagrams to illustrate concepts and provide dynamic learning experiences.
- Quizzes and Assessments: Incorporate interactive quizzes, self-assessments, and practice exercises that provide immediate feedback to reinforce learning.

Enhanced Accessibility:

- Adaptive Design: Offer content in various formats (text, audio, video) to accommodate different learning preferences and needs, including those with disabilities.
- Customizable Features: Allow users to adjust text size, background color, and other settings to improve readability and accessibility.

Typography - Lexend

Lexend font is used for its enhanced readability and accessibility features, which significantly improve the learning experience. Its increased letter spacing reduces visual crowding, making text easier to read and process, particularly for individuals with dyslexia or other reading difficulties. The font's distinctive letter shapes help differentiate similar-looking characters, aiding in quicker recognition and comprehension. Additionally, Lexend’s design helps reduce reading fatigue, which can enhance overall reading stamina and retention of information. Its inclusive design supports diverse learners, including those with visual impairments and learning disabilities, while its modern, professional appearance ensures a consistent and appealing presentation of text throughout the textbook. Overall, Lexend’s attributes contribute to a more accessible and engaging educational material.

LEXEND

ABCDEFGHIJKLMNOP
QRSTUVWXYZ

abcdefghijklmnopqrstu
vwxyz

1234567890

Colors



Symbolizes trust and calmness
Associates with clear thinking and communication.



Design Thinking involves observing user, behavior to get insights, understand needs green symbolizes growth, observing and gaining new perspective.



Reflects compassionate understanding perspective, emotion, experience connection and sensitivity of user needs.



Signifies process of understanding and defining problem clearly. Development of a clear understanding and insights.



Symbolizes the energy optimism. needed for brainstorming and thinking out of the box. Fresh perspective and opportunity.



Where ideas come to life reflects enthusiasm and excitement.

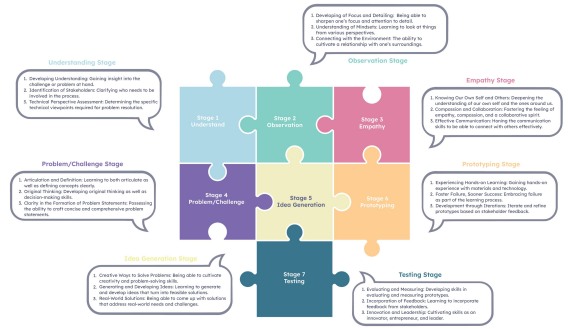


The need for and balanced approach gathering feedback, navigating through perspectives and possibilities.



Symbolizes trust, professionalism and calmness.
Associates with clear thinking and communication.

Ideation



Moreover, design thinking has become increasingly important in the early stages of startups as it helps to identify customer desires and create innovative solutions to meet their needs. By using a human-centered approach, startups can create products and services that resonate with their target audience and provide value in a unique and meaningful way.

For any startup to implement design thinking, it has to create a culture. Educating the team, encourage everyone, seek help from design advisors this is how design thinking assists in startups. Once you have attained these, you can create an ecosystem of design thinkers. Going forward, these design thinkers will help to maintain the culture and inspire the team with new ideas at each stage.

Design thinking is used by companies large and small, corporates and start-ups, private and non-profit businesses alike. Start-ups move fast. You have to create, test, and (often) fail before you figure things out. Design thinking is adaptable and iterative, so it's incredibly useful for start-ups at all stages of development whether you're just starting your business or if you have a successful product with a business model. (6)

Design Thinking Best Practices

There are several processes that we can find across the globe,



FIGURE 7 DESIGN THINKING PROCESS PROPOSED BY STANFORD WHICH IS MORE HUMAN CENTRIC (7)

(6) Peter Hinssen, Nathan Furr, Jeff Dyer, Innovation Engineering: Entrepreneurial Skills for Competitive Advantage, Wiley, 2011

(7) Nathan Furr, Jeff Dyer, The Innovator's Method: Bringing the Lean Start-up into Your Organization, Harvard Business Review Press, 2014

Stanford's Approach to Design Thinking

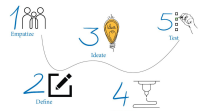


FIGURE 8 DESIGN THINKING PROCESS PROPOSED BY MIT WHICH IS MORE PRODUCT BASED (8)

MIT's Approach to Design Thinking

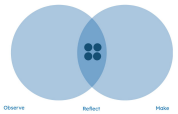


FIGURE 9 DESIGN THINKING PROCESS PROPOSED BY IDEO (10)

(8) Rafael Veiga, Author, Unmaze | Copyright CBPro © 2023 https://www.cbpro.com/blog/design-thinking-explained-7-stages-of-the-process-for-creative-innovation

things essential at the time of problem articulation.

- Validation: Are you Asking the correct/right questions.
- Verification: Are you answering the questions currently i.e., are you Getting the correct/right answers.

The next stage, Ideation, is where you start the future in the face. You begin to wonder where the future might divert from the familiar flows of the past, how the insights could be translated into new possibilities. Engineers incorporate their personal experiences and intellect with empathy and understanding for all stakeholders to develop human-centered products or services.

It is crucial to start with possibilities

- In addition to tools, it is important to have different kinds of people involved in the process of generating ideas, and accordingly, this usually includes the people who will be "served" by the solutions in their capacity as experts on their own experience. Thus, always focus on having your stakeholders are part of your team also. Because Design Thinking is all about co-creation.
- In addition to the multidisciplinary project team, other members are selected, such as users and professionals in fields that are pertinent to the subject under study, usually through Co-creation Workshops.
- The purpose of bringing together such varied expertise is to contribute varied perspectives to make the final result richer and more compelling.

Prototyping allows you to test and refine your ideas through iterative cycles of feedback and improvement. By creating tangible representations of your concept, you can better understand how it will work in the real-world, identify potential flaws or issues, and make adjustments accordingly. It's important to remember that prototyping is an ongoing process, and the best prototypes often evolve and improve over time based on user feedback and testing.

Testing is the next stage in the design thinking process. You often perform tests together with the prototyping stage. Through testing, you can learn more about your users, improve your prototype and even refine your problem statement. After generating ideas and gathering information about your users, you can create low-fidelity and high-fidelity models (prototypes) inspire engineers to visualize options and inform possible solutions. Engineers test many versions of their prototypes as they develop, implement, and evaluate possible solutions - which over time improves their understanding of the problem. Assessing and talking through iteration cycle outcomes allows engineers to simultaneously and repeatedly define and refine both their understanding of the problem and ideas for solutions.

CHECKPOINT

Fill in the blanks with your knowledge from the above section:

01. In the 1960s, the concept of _____ was introduced that highlighted the complex nature of various design challenges.

02. The 1970s saw the idea of _____ and _____ emerge as the core principles of design thinking that involved creating rough drafts or models and testing them in real-world settings.

03. The design thinking process of IDEO has the following stages: _____, _____, _____, _____, _____ and test.

04. The deep insights into stakeholders' needs are gathered in the _____ phase of the design thinking process.

05. Usability has three main facets which are: _____, _____, and efficiency.

06. The categorization the design thinking stages can be as: _____ and Problem _____.

07. According to neuroscience, empathy is typically divided into understanding thoughts, _____, and _____.

08. Designers start to envision future possibilities and how insights are transformed into viable solutions in the _____ stage.

09. Prototyping is essential because it allows for _____ and _____ based on feedback.

10. The final stages of the design thinking process involve _____ the prototypes to refine the problem statement and learn more about user needs.

- Here teams are multidisciplinary spanning from business to behaviour sciences. The research team observe users during product evaluation and also purchase decisions through videos and photographs apart from interviews.
- It uses photographs and videos in actual locations of the companies to observe how they feel and why they feel so in that location.
- The insights gained, are developed into problem statements which help in evaluating the experience in using products and encourages you to take pictures and videos and write descriptions regarding users' feelings on various aspects of the product/service.
- Prototypes are made in an iterative manner where feedback of users is prime and the suggestions are incorporated quick and tested fast until the users are satisfied with the product/service.
- It encourages employees and the employees of client companies to take part in the research project as design thinking is about co-creation.
- you can consider the example where Steve Jobs objected the mouse as it made noise on its movement and this gave the team an idea of

From Engineering Design to Design Thinking

As tech industry ripens and as organizations scale & grow to unprecedented levels of influence, new specializations are evolving across all disciplines. The work of design engineering is rapidly joining the ranks of functions demonstrating real business value.

This work involves individual workflows and organizational structures that allows collaboration and communication at the intersection of design and engineering ,and also when it comes to product, marketing, and stakeholders. This also involves team's product and process functionality understandings the speedy with the best practices. This work involves the design engineer to focus on setting up a design system, documenting patterns, performing workflow audits and updates, building UI components, writing usage documentation and working with stakeholders spread across an organization. Tasks can also include establishing and maintaining a local development environment, testing and release management.

Design engineering not only creates seamless working of engineers and designers but also serves to facilitate collaboration and communication between design, product, engineering and marketing.

Most of the steps involved in design engineering can be encompassed into the design thinking process. And this engineering design gradually

evolved into design thinking. Design thinking is very crucial when it comes to engineering, whether it is about understanding, observing, defining problems faced by customers, problems being articulated, ideas been generated, sorted, chosen and then solutions being created along with the plan of action that are then rapid prototyped and tested.

Reverse engineering

Reverse-engineering is the act of analyzing an object to see how it works, i.e. dismantling. It is done primarily to analyze and gain insights about the way something works but often is used to duplicate or enhance the object. Many things can be reverse-engineered, including software, physical machines, military technology and even biological functions related to how genes work.

Reverse engineering can be used as a tool in the Design Thinking process at the time of understanding and observation i.e, when one needs to understand and observe any product/service/process to analyze and then synthesize the same. Reverse engineering comes into play also at the time of prototyping in design thinking when you want to get feedback from the users and then further iterate.

The purpose of reverse-engineering is to find out how a product or service or process is performing. There are a variety of reasons to do this. Reverse-engineering can be used to learn how something works and to recreate the product or service or process or to create a similar object with enhancements.

The steps involved in reverse engineering are first the information extraction, followed by modelling, and reviewing.

Check these Cases Out:


Chapter 1 Introduction to Design Thinking
IBM's Approach to Design Thinking
IBM approaches design thinking in a different way, where it has the process revolve around three core principles:
Observe
Reflect
Prototype
Test
Observe
Point of view
Ideate
Prototype
Test
Understand
FIGURE 13 DESIGN THINKING USED AT SAP [34]
Design Thinking
INFO
Synthesis
Generate ideas, make connections
INSIGHTS
Synthesis
Explore & Empathize
IDEA
Synthesis
Try Experiment, Prototype
SAP's Approach to Design Thinking
Introduction to Design Thinking Chapter 1
FIGURE 13 DESIGN THINKING USED AT SAP [34]
Comprehension
Problem Understanding
Consideration
Idea Development
Creation
Solution Development
Check
Solution Testing
Carry out
Business plan/ pitch
Consciousness
Opportunity Recognition
FIGURE 12 PROCESS OF ENTREPRENEURIAL DESIGN THINKING

Learnings

Research and Presentation:

- Gained extensive knowledge of engineering education and design thinking.
- Improved research skills and the ability to present complex information effectively.

Interactive and Visual Learning:

- Explored various methods to make educational content more interactive and engaging.
- Developed skills in designing infographics and interactive learning materials.

Video Production and Editing:

- Enhanced proficiency in creating, editing, and finalizing videos for various platforms.
- Learned how to incorporate feedback to improve video content.

Textbook Design:

- Acquired skills in designing educational textbooks using InDesign.
- Learned the importance of iterative design and incorporating feedback for continuous improvement.

Project Management:

- Improved ability to manage multiple tasks and deadlines.
- Gained experience in balancing creative work with project requirements and timelines.

References

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