The Design Process of Commercial Circuits

Group A Team 10 disc24group10@gmail.com

David Chen
Viterbi School of Engineering
University of Southern California
Los Angeles, United States
dchen747@usc.edu

Ryan Kelley
Viterbi School of Engineering
University of Southern California
Los Angeles, United States
kelleyry@usc.edu

Preston Liu
Viterbi School of Engineering
University of Southern California
Los Angeles, United States
liuprest@usc.edu

Ameya Bagaria
Viterbi School of Engineering
University of Southern California
Los Angeles, United States
abagaria@usc.edu

Duy Nguyen
Viterbi School of Engineering
University of Southern California
Los Angeles, United States
dnguyen7@usc.edu

Abstract* — *All of* Modern-day technology uses electricity in one way or another. From controlling what happens and when to switching things on and off it all requires electricity. Electricity needs to be transmitted through something tangible, i.e. something physical that is a good conductor to support the flow of electrons. *Throughout this paper, how circuits work, the different kinds, and how calculations related to circuits can be made. By using a mix of the 2 types of circuits you can achieve a failsafe design that ensures that even if one fails, the other continues to work. Circuits have developed from simple ways of connecting two electronic components to being able to do everything around the house for you, using a fluctuating voltage.

Keywords—technology, modern day, electricity, electrons

I. INTRODUCTION

We have spent a lot of time, energy, and resources in order to be able to make life better and more efficient. One example was using electricity for day-to-day needs. Everything from the first lightbulb to the device controlling the fuel being pumped in a rocket going to the moon is being controlled using electricity. Technology was able to grow and become what it is today thanks to the ways electricity could be transformed for different needs. The fundamentals of electricity, voltage, resistance, current and power all play vital roles in paving the path towards all of technology as we know it today. Series circuits are circuits where all the components are connected from one wire to another. On the other hand, parallel circuit the direction of current cam be split at a node such that it goes in two different ways. Each type of circuit can be used for different circumstances where they may be required: connecting different types of transistors and resistors leads to using electricity to process information. In order to make circuits that power things like buses, or hospitals and apartment buildings. That involves a team of people to make the process as simple and straightforward as possible. The solutions to the problems are usually tested beforehand, and then implemented through simulations online and then made practical.

II. TEAMS

Since the projects are considered to be so large and vast a team of engineers are required to join together to help achieve the task. Usually, teams involve a leader who has command over the team and can control the team to achieve the best possible outcome. All the members of the team work together with different resources to achieve the same goal. The members may not always like each other but wanting to achieve the same goal is what drives them. The team consists of various engineers who specialize in their own field.

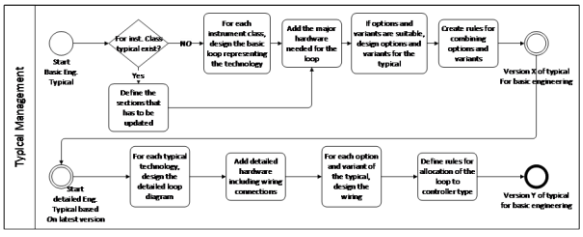

Fig.1 Design Team Flow of Power, Source [2].

III. THE IDEOLOGY AND GOAL

A. Defining The Goal

Initially the issue that is being addressed is discussed and confirmed. [3] This is so that everyone who is part of the team knows exactly what the issue is. In terms of circuit making, it could be to solve a wiring issue where there's constant fuses in a certain building or when the entire system fails to work. By understanding what each person is trying to achieve every team member knows what exactly they have to do and how it should have been done.

B. Idea

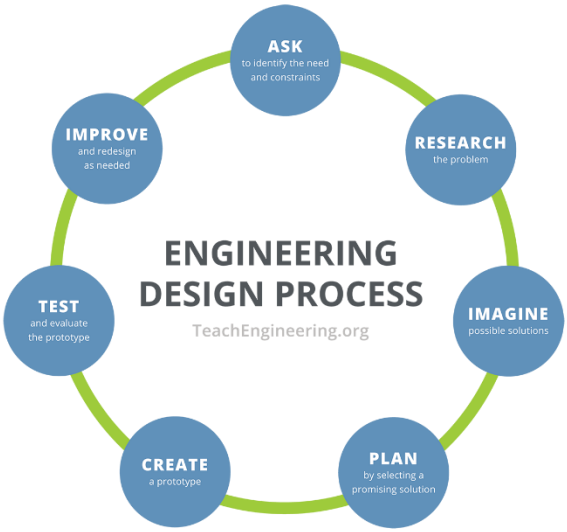

Fig. 2: The Engineering Design Process. Source: [3]

Once you know what you're roughly trying to do, then it is easy to have a rough idea in your head. But not everyone may know what you are envisioning for the process. Individually the members may imagine their own possible solution and get a rough idea of it down such that they can communicate it with the other members. Unless they can communicate what and how they are thinking, the others will not be able to contribute or offer constructive criticism. After this they can brainstorm together and work towards their solution with a rough idea in their mind.

IV. GENERATING IDEAS

Generating ideas for commercial electric circuits begins with a robust and inclusive brainstorming process. Engineers and designers gather to share and explore a wide array of concepts, encouraging creativity and out-of-the-box thinking. Techniques like mind mapping and SCAMPER (Substitute, Combine, Adapt, Modify, Put to another use, Eliminate, Rearrange) are utilized to stimulate innovative solutions. [5] Additionally, C-sketching, or collaborative sketching, is employed where team members draw and iteratively refine each other's sketches. This method helps in visualizing concepts and fostering collaborative ideation. Concurrently, market research is conducted to understand current trends, customer needs, and competitive products. This research helps identify gaps and opportunities in the market that new designs can exploit. [4]

Fig. 3: SCAMPER technique for brainstorming. Source: [5]

Gathering feedback from potential customers, stakeholders, and industry experts is equally important during this phase. Surveys, focus groups, and interviews provide critical insights into user preferences and pain points. [4] This feedback helps in refining ideas and prioritizing those with the most potential impact. [4] By combining creative brainstorming, collaborative sketching, and comprehensive research, the team can generate a diverse range of innovative ideas that align with market demands and technological feasibility. These ideas form the foundation for developing prototypes that meet the needs of the target audience while pushing the boundaries of current technology.

V. PROTOTYPE

Transforming the best ideas into viable prototype designs involves meticulous planning and execution. Engineers and designers use computer-aided design (CAD) software to create detailed schematics and simulations of electric circuits, ensuring they meet the necessary technical specifications and performance

criteria. [6] Multiple prototypes are often developed to explore different approaches and configurations. To aid in selecting the best design, a weighted decision matrix is employed. This tool allows the team to evaluate each prototype against a set of criteria, such as functionality, cost, manufacturability, reliability, and user experience. [6] Each criterion is assigned a weight based on its importance, and prototypes are scored accordingly. The design with the highest score is selected for further development.

In addition to the decision matrix, iterative prototyping and testing are crucial. Prototypes undergo rigorous evaluation to identify potential flaws and areas for improvement. [4] Testing scenarios simulate real-world conditions to ensure the prototypes can withstand operational stresses. Feedback from these tests informs iterative refinements, leading to enhancements in component values, layout, or materials. The goal is to optimize the design for performance and reliability while keeping production costs manageable. This phase also involves validating the design against industry standards and regulations to ensure compliance. Through systematic evaluation and refinement, the team can finalize a prototype design that balances innovation, functionality, and manufacturability. [4]

VI. MANUFACTURING AND TESTING

The transition from prototype to manufacturing involves several critical steps to ensure the product can be produced efficiently and at scale. Initial manufacturing runs, often referred to as pilot runs, are conducted to refine production processes and identify any potential issues. Techniques like PCB (printed circuit board) fabrication and assembly are used to produce small batches of the prototype. [7] These prototypes undergo extensive testing to evaluate their performance under various conditions, including stress testing, environmental testing, and user testing. This phase helps identify any design flaws, manufacturing defects, or areas that require improvement.

Based on the feedback from testing, iterative improvements are made to the prototype. Engineers can adjust the component values, layout, or materials to optimize the circuit's performance and reliability. [7] This iterative process continues until the prototype meets all design specifications and performance standards. Collaboration with suppliers and manufacturers is crucial during this phase to ensure the availability of quality components and to streamline the production process. [4] The goal is to achieve a balance between performance, cost, and manufacturability, ensuring the final product can be produced at a large scale without compromising on quality.

VII. MASS PRODUCTION AND ADVERTISING

Once the prototype has been perfected, the focus shifts to mass production and marketing. Establishing a reliable and efficient manufacturing process is critical for scaling up production. This involves securing partnerships with trusted suppliers and manufacturers to ensure a steady supply of high-quality components. [4] Production lines are optimized for efficiency, and quality control measures are implemented to maintain consistent product quality. [8] Simultaneously, a comprehensive marketing strategy is developed to promote the product to the target audience. Advertising campaigns, social media promotions, and participation in industry events help generate awareness and drive sales.

Marketing efforts are tailored to highlight the product's unique features and benefits, addressing the needs and preferences of the target market. [8]Effective advertising communicates the value proposition clearly, differentiating the product from competitors. In addition to traditional advertising channels, digital marketing and influencer partnerships can be leveraged to reach a wider audience. [4] The goal is to create a strong market presence and build brand recognition, ensuring the product's successful launch and sustained demand. Customer feedback and market response are monitored closely to inform future marketing strategies and product improvements.

VIII. SURVEY AND OBSERVATION

After the product is launched, continuous monitoring and feedback collection are essential to assess its performance in the market. Surveys and feedback forms from customers provide valuable insights into user satisfaction and identify any issues or areas for improvement. Analyzing sales data, customer reviews, and support inquiries helps the team understand how the product is performing in real-world conditions. This information is crucial for making further enhancements and planning future updates or versions of the product. [9] Regular performance observation ensures that the product remains competitive and meets evolving customer needs, sustaining its success in the market.

In addition to direct customer feedback, market trends and competitor analysis are conducted to stay informed about industry developments. [4] This proactive approach allows the team to anticipate changes in customer preferences and adjust the product or marketing strategies accordingly. Post-launch support and maintenance are also critical to address any issues that arise and ensure customer satisfaction.

[4] By maintaining a focus on continuous improvement and response to market feedback, the product can achieve long-term success and maintain a competitive edge in the market.

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