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GAD Builder: A Cross Platform Design Customization Tool.

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ABSTRACT

GAD Builder is a cross-platform design automation tool developed to simplify and speed up the customization of engineering models, especially in sectors like motor and transformer manufacturing. Traditional CAD tools require engineers to manually edit drawings even for minor modifications, often consuming several hours and increasing the chance of human error. GAD Builder solves this by introducing a component-based, visual customization interface where engineers can easily enable, disable, or reposition components such as T-boxes, fan covers, and shafts. Each part is treated as a modular SVG file, allowing seamless integration and instant PDF generation without affecting the integrity of the base design.

This approach reduces design modification time by up to 80%, boosts consistency, and improves overall efficiency. Key features include user authentication, smart project and component management, dynamic structure handling, and redundancy detection using MongoDB. The system is scalable and designed to support both individual users and teams, with upcoming features like revision history, collaboration tools, dynamic Bill of Materials (BOM), and AI-driven suggestions.

GAD Builder transforms repetitive CAD-based workflows into efficient, intelligent design processes. It helps manufacturers of all sizes save time, reduce errors, and deliver high-quality custom drawings faster, making it a valuable tool in modern engineering environments.

KEYWORDS

GAD Builder, CAD Automation, SVG, Customization, PDF Export, Engineering Design Testing

1. INTRODUCTION

In the field of engineering design, especially in industries like motor manufacturing and transformer production, companies rely heavily on base models that have been developed and refined over decades. However, when clients request small modifications—such as moving a terminal box (T-box), removing a fan cover, or adjusting shaft dimensions—engineers are forced to make these changes manually using traditional CAD software like AutoCAD. challenging to carry out all alone or on Although these modifications are minor, the process is time-consuming, repetitive, and prone to error. This is where **GAD Builder** offers a game-changing solution.

GAD Builder is a modern, cross-platform design automation tool created to simplify and accelerate the process of customizing General Arrangement Drawings (GADs). It replaces complex CAD editing with a user-friendly interface that allows engineers to toggle components on or off, reposition elements, and generate accurate, production-ready PDF outputs within minutes. Each component of the drawing is stored as an individual SVG file, allowing for modular control and seamless updates without disrupting the entire design.

The goal of GAD Builder is to reduce manual effort, increase design consistency, and improve turnaround time—saving up to 80% of customization time. With support for project management, component nesting, smart redundancy detection using MongoDB, and scalable design workflows, it offers immense value to both small workshops and large enterprises. Future updates include real-time collaboration, dynamic bill of materials (BOM), and AI-powered suggestions for optimal component placement.

By transforming traditional CAD-based workflows into intelligent, automated processes, GAD Builder enhances productivity, reduces errors, and helps engineering teams focus on higher-value tasks. It is not just a tool, but a step towards the future of efficient and scalable engineering design.

2. LITERATURE SURVEY

1. Introduction to Engineering Design Automation: Overview of Automation in Engineering Design: Discussion of how design automation tools have transformed engineering processes by reducing repetitive manual work, particularly in industries like electrical, mechanical, and automotive sectors. Tools like

CAD have been the standard for decades but often require extensive manual changes for minor modifications.

Importance of Drawing Customization: Emphasizing the significance of quick and accurate modifications to engineering drawings for client-specific customizations, which is essential for reducing lead time and increasing productivity.

Challenges in Traditional Design Workflows: Addressing the challenges of manual CAD work such as time consumption, human errors, complexity in handling multiple revisions, and scalability issues.

2. In the Customization of General Arrangement Drawings (GADs):

Component-Based Systems: Overview of how modular, component-based approaches—like using SVG layers for each part of the design—allow for faster and safer design edits without affecting the entire model. **User-Friendly Interfaces:** Highlighting the impact of visual, no-code interfaces in empowering even non-CAD users to perform complex customizations efficiently.

3. In Data Handling and Redundancy Detection: Use of MongoDB for Smart Detection: Review of how MongoDB's document structure and read-only collections are used to uniquely store design combinations and avoid redundant customizations. **Design Hashing:** Discussion on how smart hashing mechanisms ensure that repeated work is not done, improving design efficiency and history tracking.

4. In the Applications of Automation in Manufacturing Industries: Small to Medium Enterprises (SMEs): Examples of how GAD Builder democratizes access to advanced design tools for SMEs that lack dedicated CAD teams. **Cloud-Based SaaS Platforms:** Emphasis on GAD Builder's SaaS model enabling scalable, subscription-based access for widespread adoption across industries.

5. Patil and Sawant (2023) present a modular GAD customization approach using vector graphics and backend automation. Their system, tested in transformer design scenarios, reduced drawing time by over 70% and introduced smart design reuse through MongoDB indexing and component nesting logic [12].

3. OBJECTIVE

The primary objective of GAD Builder is to revolutionize the way engineering drawings, particularly General Arrangement Drawings (GADs), are customized and managed. Traditional CAD-based design processes are often time-consuming, repetitive, and prone to errors. GAD Builder aims to eliminate these inefficiencies by introducing a smart, component-based system that allows users to toggle, reposition, and modify design elements with ease.

Key objectives include significantly reducing the time required for design customization—from several hours to just a few minutes—by providing an intuitive visual interface. The tool also empowers small and medium-sized manufacturers to handle complex design modifications without investing in expensive CAD software or large design teams.

Ensuring design accuracy and consistency is another core objective. GAD Builder leverages scalable SVG components and a smart hashing system to maintain high-quality outputs while avoiding redundant work. Furthermore, it lays the foundation for collaborative design by supporting future features like real-time editing, version history, and secure access control, ultimately transforming the engineering design workflow into a more efficient, scalable, and user-friendly process.

4. PROBLEM STATEMENT

The problem GAD Builder addresses is the inefficiency and time-consuming nature of traditional design workflows in engineering industries. Engineers often spend several hours manually modifying base models in CAD software for minor customizations, which slows down production and increases the risk of errors. This process is repetitive, prone to misalignment, and not scalable. GAD Builder streamlines this by automating design changes, reducing modification time from hours to minutes, and improving accuracy, scalability, and overall workflow efficiency.

5. METHODOLOGY

1. **Introduction to GAD Builder in Engineering Design:** Overview of GAD Builder: Discussion of how GAD Builder automates and optimizes design workflows in engineering, specifically in the context of CAD modeling and structural designs. Focus on reducing manual errors and time spent in model customization. Challenges in Traditional Design: Addressing the challenges of manual design modifications, including human error, time inefficiency, and misalignment in structural design modifications.

2.**Automation of Design Modifications:** Parametric Modeling Techniques: An overview of parametric design principles used in GAD Builder, where model elements are defined by parameters, allowing automated modifications based on predefined rules. Integration with CAD Software: Explanation of how GAD Builder integrates with popular CAD software (e.g., AutoCAD,

Revit) to seamlessly implement design changes and generate optimized models.

2. **Data Sources and Preprocessing:** Engineering Data: Review of data sources including standard engineering templates, building codes, and user-defined parameters used to create adaptable models in GAD Builder. Preprocessing Techniques: Techniques for cleaning and structuring the engineering data to ensure compatibility and precision in automated design modifications.
3.
4. **Optimization Algorithms in GAD Builder:** Algorithmic Approaches: A discussion on optimization algorithms (e.g., genetic algorithms, gradient descent) used to efficiently modify designs based on the input parameters. Handling Complex Modifications: How GAD Builder tackles complex design scenarios, such as multi-dimensional modifications, ensuring structural integrity while adhering to user specifications.

5. **Visualizing and Validating Design Changes:** Visualization Techniques: Explanation of the 3D visualization tools in GAD Builder, allowing engineers to review and validate modified models in real-time. Validation Algorithms: Methods for validating that the automated design changes meet. temporal inconsistencies, capturing even subtle manipulations that might otherwise go unnoticed.[7][5]

6.**Evaluation and Performance Assessment:** Model Performance Metrics: Overview of the performance metrics used to assess the effectiveness of GAD Builder in reducing design time and errors, such as time saved in modifications and accuracy of automated designs. User Feedback and Iterative Improvement: How user feedback is integrated into the development of GAD Builder, with iterative updates enhancing usability, precision, and speed of design automation. [12][9]

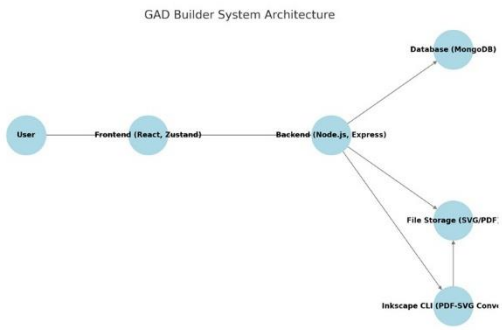

Fig1 :System Architecture

6. RESULT

Adding New Components: In GAD Builder, adding new components involves defining customizable parameters for each component, which can be integrated into existing designs. Users can specify dimensions, materials, and functional requirements, allowing automated placement and optimization within the structural model.

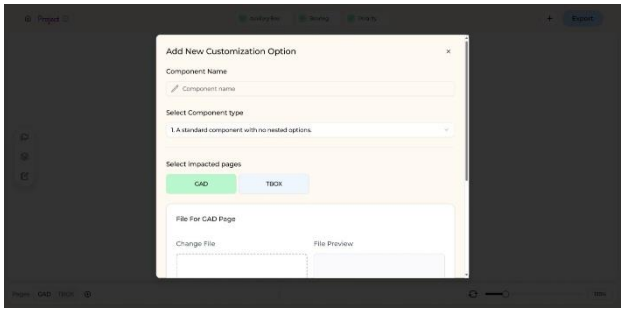

Fig 2: Adding new Custom Components

The Home Page of GAD Builder serves as the central hub for users to navigate through various features. Upon logging in, users are greeted with a user-friendly dashboard displaying project summaries, recent activities, and quick access to design tools. The homepage includes a navigation menu for easy access to sections like project creation, component library, settings, and user profile. Additionally, it showcases project templates and provides real-time notifications on project status, ensuring users stay updated on ongoing tasks. A search bar enables quick retrieval of past designs and components, enhancing overall workflow efficiency. friendly

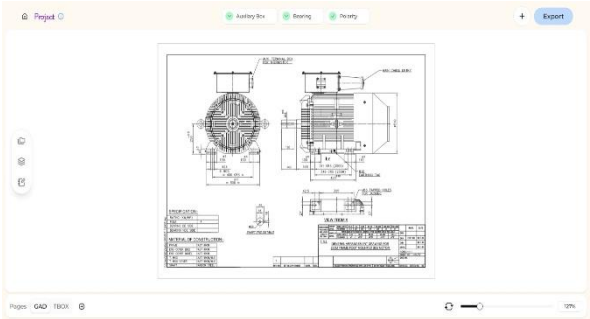

Fig 3 : Home page

In GAD Builder, users can easily change the base drawing of their project by selecting a new drawing from the component library or uploading their own. The tool provides intuitive options to replace, scale, and adjust elements to fit the new base drawing, ensuring seamless integration into the project.

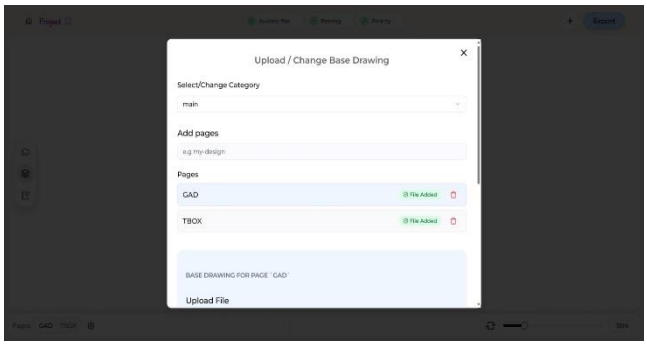

Fig 4 : Base Drawing Change

7. FLOWCHART

A Fertilizer Recommendation System flow diagram typically starts with user input of soil parameters like Nitrogen, Phosphorous, Potassium (NPK levels), pH, and crop type. This data passes through a machine learning model, which analyzes it based on predefined patterns. The system then outputs specific fertilizer recommendations tailored to optimize crop yield

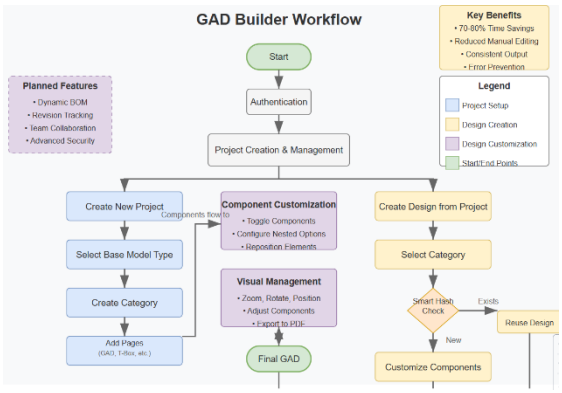

Fig 5 : Flowchart

8. CONCLUSION

The GAD Builder is a powerful tool that streamlines the design and development of various applications. By incorporating advanced features like flow charts, base drawing customization, and the ability to add new components, it simplifies the process of building complex systems. The tool enhances user experience, improves project organization, and facilitates efficient communication among developers. With its flexibility and robust functionality, GAD Builder serves as an invaluable resource for anyone involved in software design and development.

10. FUTURE SCOPE

• As artificial intelligence (AI) and machine learning (ML) continue to dominate technological trends, the GAD Builder can incorporate AI/ML capabilities for more intelligent design and development. For instance, the tool could analyze existing designs and suggest optimizations based on industry standards or user preferences. This would streamline the design process and reduce errors or inefficiencies, ensuring better end products.

• **Collaboration Features and Real-time Editing** With growing demand for remote work and team-based development, adding real-time collaboration features would allow multiple users to work on the same project simultaneously. This would include features such as live commenting, version control, and user access management, making it ideal for teams working on large-scale projects. It could also integrate with popular project management tools like Jira, Trello, or Slack, creating a seamless workflow for developers and designers.

•Cloud-based technologies are becoming increasingly important for building scalable and easily accessible applications. GAD Builder could integrate with cloud platforms like AWS, Google Cloud, or Azure to enable developers to deploy their projects directly from the tool. This would save time and improve the deployment process by providing features like auto-scaling, database management, and enhanced security.

Cross-Modal Analysis : Incorporate audio analysis alongside video to detect inconsistencies between voice and facial movements, improving overall detection rates.

•Currently, GAD Builder is mainly designed for desktop applications, but expanding its scope to mobile application development is a natural progression. With mobile apps becoming an integral part of the digital ecosystem, GAD Builder could allow users to design mobile apps, enabling compatibility with both Android and iOS. This would help developers create more responsive, user-friendly applications.

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