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Department of Computing and Mathematics

Computing and Digital Technology Postgraduate Programs

Research on innovative approaches for software utilization for the custom design of heat cylinders.

For Enhance Business and Production process.

A Dissertation submitted to Manchester Metropolitan University in part fulfilment of the requirements for the degree of

**MSC COMPUTER SCIENCE WITH PLACEMENT**

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# Abstract

Computer technology creating may positing impact in our day-to-day life including modern manufacturing industry. Traditionally engineers and manufacturers use engineering drawings for manufacturing custom products. some product required custom design like heat cylinder like each custom cylinder require specific connection on different angel and height and now days engineering drawings replace with CAD software and for manufacture need different cad design for each custom cylinder. The focus of this project is examining the user of CAD software use in designing custom cylinder, Also, find how his designing will help full in production and business process and study new approach for use of destining software that will help new modern businesses for product that are require each product custom design.

The objective of this dissertation is to study on going method for design product like custom cylinder that require different design for each custom cylinder study limitations of current process and develop a web technology-oriented software application that will work as designing tools for build customization designed cylinders with different kind of connection. Also help provide more clarification in business process and provide additional support on production process. The application will use current technologies and relevant design patterns.

# Declaration

I, Vaghela Jahna H, hereby declare that this dissertation project titled **"Research on innovative approaches for software utilization for the custom design of heat cylinders "** is my original work. I have conducted this research under the supervision of Michael Bane, and I have adhered to the ethical guidelines and academic integrity standards set forth by **Manchester Metropolitan University Department of Computing and Mathematics**.

This dissertation is a culmination of my research efforts and reflects my understanding and insights into [briefly describe your research topic or area]. All sources used in the development of this project have been appropriately cited, and I have ensured that my work is free from plagiarism.

I acknowledge that any ideas or content derived from other authors have been duly referenced and that I have received no unauthorized assistance in the completion of this project.

I understand that any breach of these principles may result in disciplinary action, including the potential for failing the dissertation.

Signed: Jahnav H Vaghela

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# 1 Introduction

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# 2 Literature Review

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## 4.1 Web Base 3D Modeling tools: WebGL and 3D tools ThreeJS and BabylonJS

In the context of custom heat cylinder design, the shift toward web-based 3D modeling tools presents a promising avenue for innovation. Traditionally, Computer-Aided Design (CAD) and 3D modeling have been confined to desktop applications, requiring substantial computational resources and proprietary software licenses. However, with advancements in web technologies such as WebGL and the development of powerful 3D libraries like Three.js and Babylon.js, it is now possible to create and deploy fully interactive, web-based 3D modeling tools that cater to the design of complex engineering components, including heat cylinders. These tools allow for real-time, browser-based design and visualization, making it easier to collaborate, simulate, and modify heat cylinder designs without relying on traditional desktop environments.

This section explores how web-based 3D modeling technologies, specifically WebGL, Three.js, and Babylon.js, can be leveraged to build web applications for the custom design of heat cylinders, offering a more flexible, accessible, and scalable solution for both designers and engineers.

**WebGL: Enabling Real-Time 3D Graphics in the Browser**

(Web Graphics Library) WebGL is a JavaScript API that enables real-time rendering of interactive 3D graphics inside web browsers without the use for third party plug-ins or additional software. Built on (Open Graphics Library for Embedded Systems) OpenGL ES, WebGL provides a powerful foundation for rendering complex 3D models and simulations directly in a browser, making it a key technology for building web-based applications aimed at the custom design of heat cylinders.

For the design of heat cylinders, WebGL allows users to interact with detailed 3D models of various cylinder configurations, enabling real-time visualization of modifications such as changes in geometry, dimensions, and material properties. This capability is particularly valuable for collaborative engineering projects, as multiple users can access and modify designs from different locations, all through a web interface. Moreover, WebGL is compatible across multiple platforms, meaning it can run on desktops, laptops, tablets, and even mobile devices, offering greater accessibility to engineers and designers working in diverse environments.

**Three.js: Simplifying 3D Modeling and Visualization**

Three.js is one of the most widely used JavaScript libraries built on WebGL, providing a simplified interface for creating and rendering 3D models and scenes in the browser. It abstracts many of the complexities of WebGL programming, making it easier for developers to build interactive and visually rich 3D applications. Three.js offers a range of features such as lighting, shading, textures, and camera controls, all of which can be leveraged to create detailed visualizations of custom heat cylinders.

In the context of heat cylinder design, Three.js can be used to create a web-based application where users can manipulate 3D models of heat exchangers by adjusting parameters like tube length, diameter, shell configuration, and baffle arrangement. Users can also apply different materials to visualize how design changes affect the thermal properties and performance of the heat cylinder. The real-time feedback provided by Three.js allows engineers to experiment with different configurations and immediately see the impact of their design decisions, thus speeding up the design iteration process.

Three.js also supports integration with various physics engines, enabling simulations of heat transfer, fluid flow, and mechanical stress within the heat cylinder. By coupling this capability with the web-based interface, users can simulate and visualize performance metrics without needing to export the design to external software, streamlining the design and testing workflow.

**Babylon.js: Advanced 3D Modeling and Simulation**

Babylon.js is another powerful JavaScript library that allows for the creation of complex 3D applications and is particularly well-suited for more advanced 3D modeling and simulation tasks. While similar to Three.js, Babylon.js offers more robust support for physics simulations, scene management, and complex animations, making it ideal for utilization that require detailed simulations of thermal and mechanical processes. For the custom design of heat cylinders, Babylon.js provides the necessary tools to model intricate geometries and simulate their behavior under various operational conditions.

In a web application for heat cylinder design, Babylon.js could be used to simulate complex phenomena such as heat transfer efficiency, pressure drops, and fluid dynamics in real time. Engineers could manipulate the design parameters within the web interface and immediately see how these changes affect performance through graphical simulations. For instance, modifying the baffle arrangement or tube configuration would instantly update the flow patterns and heat transfer rates in the simulation, providing valuable feedback for optimizing the heat cylinder's design.

Babylon.js also supports integration with WebXR (Web Extended Reality), which could enable the use of augmented and virtual reality tools in the design process. This could be particularly useful for visualizing large-scale heat exchangers or complex internal structures in 3D space, giving engineers a more immersive understanding of the design before it moves to the manufacturing stage.

**Benefits of Web-Based 3D Modeling for Custom Heat Cylinder Design**

The use of web-based 3D modeling tools like WebGL, Three.js, and Babylon.js offers several advantages over traditional desktop-based design software, particularly in the context of custom heat cylinder design.

**1 Accessibility and Collaboration**

One of the primary benefits of web-based tools is their accessibility. By running entirely in a web browser, these tools eliminate the need for specialized hardware or software installations, allowing engineers to work from any location with internet access. This is particularly valuable for remote teams or international collaborations, where engineers and designers from different locations can work on the same project simultaneously. Real-time collaboration features, such as shared design sessions and live editing, enhance the speed and efficiency of the design process.

**2 Cost-Effectiveness**

Traditional CAD software and 3D modeling tools often come with high licensing costs, making them prohibitively expensive for smaller companies or startups. In contrast, web-based solutions are typically more cost-effective, offering flexible pricing models such as pay-as-you-go or subscription-based services. Additionally, many libraries such as Three.js and Babylon.js are open-source, reducing the upfront costs associated with acquiring and maintaining expensive software.

**3 Flexibility and Customization**

Web-based 3D modeling tools offer a high degree of flexibility and customization. Developers can tailor the user interface, integrate specific design features, and include custom simulation modules to meet the unique requirements of different industries or use cases. For custom heat cylinder design, this means that specific parameters, such as fluid properties, heat transfer coefficients, and material stress factors, can be built into the application, providing a more tailored experience compared to general-purpose CAD software.

**4 Real-Time Simulation and Feedback**

Another significant advantage is the ability to perform real-time simulations and visualizations. By leveraging the power of WebGL and 3D libraries like Three.js and Babylon.js, engineers can see immediate feedback on how design changes impact the performance of the heat cylinder. This reduces the time required for design iterations, as there is no need to export models into external simulation software—everything can be handled within the same web application.

**Challenges and Future Prospects**

While web-based 3D modeling tools offer many advantages, there are still challenges to address. The performance of web-based applications can be limited by the computational capabilities of the user's device, particularly when dealing with large or complex models. Additionally, integrating advanced physics simulations, such as those required for fluid dynamics and thermal analysis in heat cylinders, may require significant development effort and optimization to run efficiently in a browser.

However, the continuous improvement of WebGL and the growing capabilities of libraries like Three.js and Babylon.js suggest that these challenges can be overcome. As browser-based computing power increases and web technologies evolve, the potential for web-based 3D modeling tools in custom heat cylinder design will continue to expand, offering a highly accessible and efficient solution for designers and engineers in the future.

Web-based 3D modeling tools, powered by WebGL and libraries like Three.js and Babylon.js, represent a significant innovation in the custom design of heat cylinders. These technologies offer flexibility, cost-effectiveness, and real-time simulation capabilities that can improve the efficiency of the design process while reducing the need for expensive desktop-based CAD software. As web-based tools continue to evolve, they hold the potential to transform the way custom heat cylinders are designed, providing new opportunities for collaboration, optimization, and innovation in the engineering field.

## 5.2 Build 3D interactive tools

A white cylinder with a clear cover

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With help of 3D available library created web based interactive tools for create cylinders design. Main component detail regarding heat cylinder can be set with tool for example cylinder height and diameter. Above tools are develop of clearer it is under development process because is part of project I start developing this but custom design heat cylinder is more complicated project, and many things are coming more requirements but concept is clear but required some more time to developer working prototype

In above tools we can create cylinder size most custom design cylinder are different is size so we can set diameter and height of cylinder also can set height of main cylinder top and bottom lid with also we can set insulation type and thickness with it nature.

Connections are most important part of custom design heat cylinder we can set number of connection and each connection can be set exact angle on cylinder and height wit that we can defined exact position also each connection is unique as per requirements and will user to connect different components like some heat cylinder use electric heater immerser heater and some user heat exchange collie base based heat exchange tube also some larger size heat cylinder has inspection opening. Each connection base on its type it can auto calculate diameter of hole on cylinder also with this we can auto calculate metal sheet height for main cylinder also for outer case. Additionally, with we can set dimer for each connection and length because some connections are required that are longer than insulation thickness.

## 5.3 Auto Calculation

Auto Calculation is one of the important parts of development of above we base interactive tools also it is necessary aspect of this project research because this is not working in conventional method of designing. In Traditional method CAD designing each part are separately design and is any change like slight change in height or diameter require design separate part also all different parts are assembler together as final design for each final custom design cylinder.

Above tools will auto calculate some of things like if we can calculate outer case size base on preset insulation thickness for cylinder diameter thickness and height. Also based on each connection we can calculate main cylinder man metal shite size with hole size depend on each connection same way we can calculate hole size for outer case. More on we can auto calculate other important things like total cylinder wait when it is empty, so we get clear idea about transportation also total capacity of heat cylinder also auto calculate with above tools. We can try to enhance this functionality and try to accommodate as much more important information required for custom design.

## 5.4 Export Data

While developing above web applications exporting data is one of most important aspects of development this project because with this we can create integration with other application like cad software also can be used for other application like can use for IOT senser during production process. for example, like we can get main cylinder height diameter and insulation type and thickness and other data can be used to generate automation and build similar design in other CAD software and testing tools where we can utilize specific advantage for specific software for unique testing like some tools can use to test design strength testing or some other tools user for module automation testing simulation run that can provide important help before we can start actual production process that can also use full for modern AI tools for test and train ne machine learning modeling. Furthermore, it can be used as a future tool for support industry 4.0 application developments.

## 5.5 Calculate Matal Sheet Size with hole size and position

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One of main features expected for above tools is for find actual size for metal sheet with hole size because this hole size is used for connecting different connecting for custom requirements metal sheet are main component in building custom heat cylinders and it is required to calculate exact size base on main sheet we can add correction for welding process. Same way outer case for heat cylinder size also calculated. In production process this is important data that will help full for working to understand also this type for metal sheet are fist cut as per each design and make holes with different technics after that this sheet re rolled for make cylinder after then with top bottom lid and stand are welded with cylinder then final other components re welded. This will be useful for production process for make this as automation.

## 5.6 Try to Generate CNC Code and DFX File

CNC code is an industry standard accepted by many industries. Also, this is important part is should development expectations like metal sheet size and holes has position each hole are located on sheet component are set on height and angle on cylinders on that position of hole on metal sheet this like distance of hole center is is 300 mm form left size and 500 millimeter from top also hole diameter is 30mm on base of this we can wire CNC code like x300y500 and base on each machine unique CNC code can be generated that will help production process to overall production can be made automated. This kind of support will help many industries and factory that re involve in manufacturing custom heat cylinders. In conventional method for designing software are not support generating this type of automation or supported vision for production this is one of concepts that will helpful than traditional designing process.

Compare to conventional tools that based on cad design are expensive and required expert skills and required expensive hardware this can become most expensive solutions for business also heir expert that can operate this software are difficult to operate also that are not more useful wile communicating with clint CAD software can user for make drawing file. Also, for production and manufacturing process are not supported with conventional software. This web base tools is part of this project to explore more possibilities with different technology.

# 6 Evaluation

# 7 Conclusion

# References