

A REVIEW PAPER ON REVERSED ENGINEERING**K. Deepika¹, Ch.Jeeven kumar², B. Mani Teja³, G. Sridhar⁴, P. Rahul Kumar⁵, R. Sai Charan⁶**¹Assistant Professor, Department of Mechanical Engineering, GNIT, Hyderabad, Telangana.²Assistant Professor, Department of Mechanical Engineering, GNITC, Hyderabad, Telangana.^{3,4,5,6} UG Scholars Department of Mechanical Engineering, GNIT, Hyderabad, Telangana.**ABSTRACT**

This project focuses on enhancing disc brake calipers, essential for vehicle braking systems. Through reverse engineering, the project will dissect and analyse an existing caliper to understand its design and functionality. Techniques like 3D scanning and CAD modelling will be used to create a digital representation, which will form the basis for a new prototype using rapid prototyping technologies. The aim is to not just replicate but improve the current design, boosting the caliper's performance and efficiency.

Keywords:

Brake caliper, rapid prototyping, reverse engineering, 3D scanning, calibry nest software.

LITERATURE SURVEY

- **Mirko Sokovic, J Kopac**, reverse engineering (RE) plays a crucial role. It involves generating surface models using three-dimensional (3D) scanning techniques. These models facilitate the production of various components (such as car parts and household appliances) and tools (including Molds, dies, and press tools) within a short development period. RE provides significant benefits to both design and production processes by allowing optimization before manufacturing. [1]
- **William B Thompson, Jonathan C Owen, HJ de St Germain, Stevan R Stark, Thomas C Henderson** researched on Reverse engineering involves extracting information about a specific mechanical part to replicate it using appropriate manufacturing techniques. This process is crucial when functional CAD models are unavailable or unusable for duplicating or modifying parts. Computer vision techniques, applied to three-dimensional (3-D) data acquired through noncontact 3-D position digitizers, can significantly aid the reverse engineering process. However, challenges related to accuracy must be addressed to ensure that models generated from sensed data are truly useful for manufacturing operations.[2]
- **Zoran Pandilov, Betim Shabani, Dejan Shishkovski, Gligorche Vrtanoski Acta Technica Corviniensis-Bulletin of Engineering 11 (2), 113-118, 2018** researched on Reverse engineering (RE) has extensive applications in industry and various fields. It involves creating a three-dimensional (3D) data file of an existing physical model on a computer-aided design (CAD) system. This paper analyses real-world scenarios in an industrial plant, comparing current measuring methods with the potential of digital measurement. RE aims to reduce the time required for dimensioning and modelling complex mechanical parts. Practical examples of parts produced in a manufacturing factory are also discussed. Digitalization is crucial for measurement and quality control activities in every company.[3]
- **Atul Kumar, Pramod Kumar Jain, Pushparaj Mani Pathak DAAAM international scientific book 39, 665-678, 2013** researched on Reverse engineering plays a vital role in mechanical design and manufacturing. It is recognized as an essential technique in the product design cycle. When original drawings or documentation are unavailable, reverse engineering involves reproducing a CAD model of an existing part using digitization techniques. The process includes characterizing geometric models, surface representations, segmentation, and creating accurate CAD models. By applying reverse engineering, product redesign and research can significantly reduce production time and costs in manufacturing industries.[4]

- **Kwan H Lee, H Woo researched on** The design models for new products are often created using clay or wooden mock-ups. Reverse engineering (RE) technology allows us to rapidly create CAD models by capturing the surface of a physical model using laser digitizers or coordinate measuring machines. Rapid prototyping (RP) further reduces product development time by fabricating physical prototypes using layered manufacturing techniques. However, in the reverse engineering process, dealing with the enormous point data generated by digitizers is time-consuming and inefficient for creating surfaces. Additionally, surfacing operations can be a bottleneck. RP typically uses STL files, which approximate CAD models using planar triangular patches but have limitations. A novel procedure integrating RE with RP addresses these challenges, including algorithms that significantly reduce point cloud data. These methods enhance the use of reverse-engineered geometric data for rapid prototyping, ultimately contributing to shorter product development times.[5]
- **Kevin N Otto, Kristin L Wood researched on** A reverse engineering and redesign methodology for product evolution In response to the constant drive for business growth, industries seek innovative methods to enhance their products. Our proposed approach combines reverse engineering and redesign. We begin by understanding customer needs, followed by reverse engineering and creating a functional model through teardowns. Specifications are then aligned with customer requirements. Depending on the redesign scope, new features may be introduced. Models are developed and optimized, leading to the creation of an improved product form. An electric wok redesign serves as an illustrative example. This methodology has positively impacted both design education and practical application.[6]
- **Venkat Deepak Kolar researched on** The automotive industry increasingly relies on reverse engineering for remanufacturing spare parts. This thesis explores techniques using Fused Deposition Modeling (FDM) for reverse engineering vintage automotive components. The project aims to create part-to-CAD and CAD-to-part reconstructions of original parts. These 3D models will be added to the 3D Part Database. By integrating reverse engineering and rapid prototyping, the conflict between design and manufacturing is resolved, allowing faster product launches. Rapid prototyping technology has significantly impacted global manufacturing. In particular, it has found successful applications in metal casting. The thesis investigates potential uses for metal casting and explores technological limits, emphasizing how further development can better serve manufacturing requirements.[7]
- **KARTHIK TRV, C RAGHUNATHA REDDY, GANESH KUMAR YADIKI researched on** A brake is a device that applies artificial frictional resistance to stop the motion of a machine. Brakes absorb either kinetic energy from moving parts or potential energy from objects being lowered by hoists or elevators. The absorbed energy is dissipated as heat. Disc brakes are commonly used in automotive applications for cars and motorcycles. They consist of a disc sandwiched between two pads, actuated by pistons in a caliper. When the brake lever is pressed, hydraulically pressurized fluid forces the pads into frictional contact with the disc. Friction brakes generate frictional forces as surfaces rub against each other. The stopping power depends on the contact area, coefficient of friction, and actuation pressure. Wear occurs on the working surfaces, and durability relies on the type of friction material used. Introducing cut patterns on the disc can impact heat transfer rates and cooling efficiency. However, excessive cuts may weaken the disc, affecting its strength and potentially leading to breakage.[8]
- **Achebe Chinonso Hubert1 Nnamdi Benedict Anosike, Abulrahman Jibrilla Adamu researched on** the impact of modern manufacturing techniques, specifically Advanced Manufacturing Technology (AMT), on small and medium-sized enterprises (SMEs) in the production of automotive parts, particularly the rear hub for motorcycles. By leveraging reverse engineering and Rapid Prototyping (RP), manufacturers achieve advantages such as reduced risk of failure and shorter time-to-market due to faster product life cycles. Rapid prototyping technologies now allow the creation of parts resembling mass-produced components in a remarkably short time. These reverse-engineered parts maintain standard quality and seamlessly fit into existing systems. The paper details the CAD modeling of a CY 80 motorcycle rear hub using dimensions obtained from a Coordinate Measuring Machine (CMM) in Creo/Pro-E 5.0. However, challenges were encountered when using point cloud data to create a 3D axis-

symmetry model, prompting recommendations for enhancing axisymmetric modeling in CMM CAD software.[9]

- **T Kucklick** The Medical Device R&D Handbook, 161-192, 2006 Researched on Reverse engineering involves disassembling a product to understand how it works and creating a functional replica or an improved version. It aims to recover the top-level specifications and comprehend the underlying principles of a product. Related concepts include reverse modelling and image reconstruction. While some view RE negatively when it involves intellectual property theft, it is a valuable tool for studying existing technology, making improvements, and developing compatible products. If you've ever taken things apart out of curiosity, you've engaged in RE—a crucial method for advancing clinical technology.[10]
- **CV Gopinath, D Pavan Kumar, T Sonesh, A Srinivas** researched on DESIGN AND ANALYSIS OF INTERNAL COMBUSTION ENGINE PISTON WITH REVERSE ENGINEERING, The automobile industry has benefited significantly from CAD/CAM technologies, impacting both engine performance and aesthetics. Recent advancements in geometric modeling and Computer Integrated Manufacturing (CIM) have reduced manufacturing lead times. Designing Internal Combustion Engine (IC engine) parts is crucial for enhancing automobile functionality. Reverse engineering plays a key role in generating digitized data from complex components. This paper focuses on the modeling and analysis of IC engines.[11]
- **ON Nwoke, PDI Ndubuisi, IU Mbabuikie** researched on Reverse engineering allows extraction and use of design information from a component or system, either for re-creation or related tasks. However, achieving this is challenging due to the lack of a perfect approach or tool guaranteeing effortless recreation of a complete CAD model from physical parts. This paper addresses this gap by conducting a replicable reverse engineering task on an Indesit front-loading automatic washing machine. The goal is to foster better synergy and participation among stakeholders (industries, academia, entrepreneurs, and governments) for cost-effective technology transfer and innovation in the modern technological landscape. The process involves data capture, preprocessing, segmentation, surface fitting, and CAD model creation for the referenced laundry washer prototype.[12]
- **Engin Kanun, Ganime Melike KANUN, Murat Yakar** researched on Reverse engineering involves re-measuring existing manufactured parts and creating 3D models based on them. It is widely used for repairing damaged parts, improving used components, and designing new ones. Among the various reverse engineering methods, photogrammetry stands out. Photogrammetry encompasses applications using professional cameras to mobile phones and is categorized into terrestrial, aerial, and underwater branches. The common thread is making measurements of structures or regions and creating 3D models, even with different equipment. In a study, a rear brake disc for a personal passenger car was modeled using mobile photogrammetry. The method demonstrated easy applicability, low cost, and high accuracy (0.88 mm).[13]
- **Antonio Lanzotti, Fabrizio Renno, Michele Russo, Riccardo Russo, Mario Terzo** researched on virtual prototyping using reverse engineering techniques for an automotive semi-active differential based on Magneto-Rheological Fluid (MRF). The MRF enables control of locking torque, enhancing vehicle handling. The process involves 3D digitizing and virtual reconstruction of a common front-wheel-drive vehicle's gearbox. By defining the boundary volume of the new MRF LSD (limited-slip differential) device and creating a preliminary CAD model, the final virtual prototype is obtained. Optimization of dimensions and material selection contributes to the quality of the model. Physical prototypes are manufactured to validate the design process through experimental tests.[14]
- **Chaitanya Thakur** : An overview of Reverse Engineering is that it is the procedure in which a given object is thoroughly examined, just to procure an abridged knowledge of its origination and functionality. This information usually contains structure charts, data description and PDL to describe processing details. Various steps within reverse engineering are followed to procure this knowledge. The reverse engineering starts with an executable program. The tools that Reverse Engineering procedure

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uses are dissembler and compilers, and some other tools are also used as per the need. In past, reverse engineering was drawn parallel with the shady and illegitimate uses in context to software piracy. But today, reverse engineering is applied for lots of legitimate applications. In this paper, a detailed view of the Reverse Engineering, Tools and techniques, Uses, and some History of Reverse Engineering is given.[15]

- **Danielle Babb** researched on Reverse engineering, which sometimes can be referred to as back engineering, is the process through which aircraft, software, machines, and architectural structures, among other different products, are decomposed to get design information. In most cases, the process of reverse engineering surrounds the deconstruction of individual constituents of more significant merchandise. This paper introduces the reader to popular concepts, uses, stages and future of reverse Engineering. It shows how Reverse Engineering is continually evolving and shaping the concept of Cyber Security[16]
- **Feng et al** researched on present that 3D scanning is a novel method to obtain initial geometric imperfections. This technology presents the object in point cloud data. The experiment was conducted, and we identified a reduction of geometric imperfections during the self-balanced process.[17]
- **Andrews et al** researched on proposed that 3D scanning is a non-touch measuring technique that is feasible and increases performance. This technology can be used to see the growth 14 of preterm infants.[18]
- **Javaid et al** researched on presented that 3D scanning is quite efficient in dentistry, and its applications are to create innovation in dental implants, tools, and devices. It is helpful for the design and development of dentures, braces, veneers, and aligners. It provides a better understanding of the teaching and learning process.[19]
- **Tai-Shen Huang** researched on Product development process can be time-consuming and difficult to manage. However, the time taken to complete the design portion of the process can be reduced by using reverse engineering and rapid prototyping techniques. This paper describes a novel design process for the development of objects made of soft material, and a diving glass has been presented as an example during the design process. In order to reconstruct the CAD model of objects of complex geometry, a laser scanner and reverse software was used to retrieve the form information of the objects. Since the communication between designer and client is very important, the use of remote access software can provide instantaneous interaction and feedback on designs. This method makes it possible to view and fully-interact with one computer from any other computer or mobile device anywhere on the Internet. For ultimate simplicity, there is even a Java viewer, so that any desktop can be controlled remotely from within a browser without having to install software. In this product development process, rapid prototyping allowed for physical models of a design of any shape and geometry to be created quickly. It also provided an opportunity to test different features and then change the design to create a more complete model. Finally, the result of design can be display on the screen by using virtual reality technology.[20]

CONCLUSION

Brake calipers play a vital role in controlling vehicle speed in the automotive industry. Redesigning and reproducing this crucial component efficiently is essential, making reverse engineering a key process. By utilizing 3D scanning, the time taken to collect dimensions and data is significantly reduced, streamlining the process. This allows for the creation of accurate 3D models in less time through reverse engineering, ensuring precise dimensions are captured effectively. Furthermore, 3D prototyping enables the production of the 3D model, facilitating the refinement and optimization of the brake caliper design. Ultimately, this integrated approach enhances the efficiency and effectiveness of the redesign and reproduction process for brake calipers in automotive applications

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