

REVERSE ENGINEERING AND PROTOTYPING OF TWO WHEELER SPROCKET HUB

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Abstract - This project successfully reverse engineered and prototyped a two-wheeler sprocket hub. A 3D scanner captured the geometry of the original sprocket hub, generating precise data for a digital model. Geomagic software was then utilized to process the scan data and create an STL file, suitable for 3D printing. The final stage involved 3D printing the sprocket hub prototype using a material chosen for its strength and durability. This project not only achieved a comprehensive understanding of the sprocket hub's design through 3D scanning, but also produced a functional prototype for comparison with the original component in terms of dimension, function, and performance. The knowledge gained through this project is valuable for sprocket hub maintenance, repair, and potential future modifications.

Key Words: Two-wheeler sprocket hub, Reverse engineering, 3D scanning, Prototyping, 3D printing, STL file.

1. INTRODUCTION



Figure 1. Two Wheeler Sprocket Hub

The world of motorcycles and scooters thrives on a network of intricate components working in harmony. Among these essential players is the two-wheeler sprocket hub, a seemingly simple yet crucial element within the drive train system. This component fulfills a dual purpose: firstly, it acts as the heart of the rear wheel, offering a sturdy foundation for the spokes and rim, ensuring smooth rotation. Secondly, the

sprocket hub serves as a power distributor. A sprocket, featuring teeth, is either integrated with or attached to the hub. This sprocket collaborates with a chain, effectively transferring power from the engine to the rear wheel through the chain drive system.

The design and materials chosen for a two-wheeler sprocket hub significantly impact the overall performance, handling, and durability of the vehicle. This report delves into the complexities of the two-wheeler sprocket hub, exploring the various types (based on attachment method and material), factors influencing sprocket hub selection (weight and power handling capabilities), and important considerations for maintenance and replacement. By gaining a comprehensive understanding of the two-wheeler sprocket hub, we can cultivate a deeper appreciation for this fundamental component that keeps motorcycles and scooters rolling.

2. Introduction to Reverse Engineering

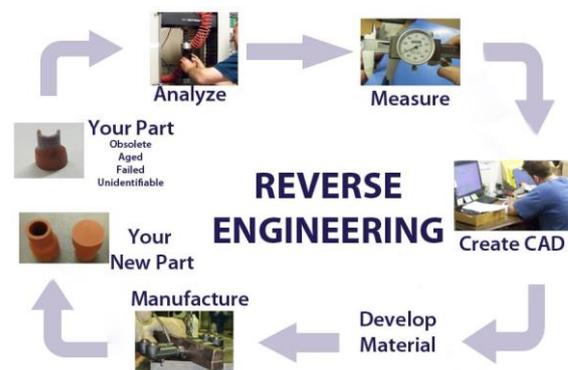


Figure 2. Reverse Engineering Process

In the world of technology, reverse engineering is like dissecting an invention to understand how it works. We can take apart anything, from a physical device to software, to learn its secrets. This knowledge can be a key to repurposing old objects, improving security in software, or even inspiring

entirely new creations. It's a powerful tool for learning and innovation!

3. Introduction to 3D Scanning



Figure 3. 3D Scanning Equipment

3D scanning is a technology that captures the 3D shape and, sometimes, color of a real-world object. Imagine creating a digital replica of a statue or a toy car! The scanner uses various technologies like lasers to achieve this. The captured data is then converted into a 3D model which can be used for various purposes.

This technology is used in many fields. In product design, it allows for creating digital models before going into physical production. In healthcare, 3D scans are used to create custom prosthetics. 3D scanning is constantly evolving and is sure to play an increasingly important role in the future.

4. Introduction to 3D Printing



Figure 4. 3D Printer

3D printing, also known as additive manufacturing, is a revolutionary technology that builds objects layer by layer. Unlike traditional methods that carve away material, 3D printing uses a digital blueprint to create intricate shapes.

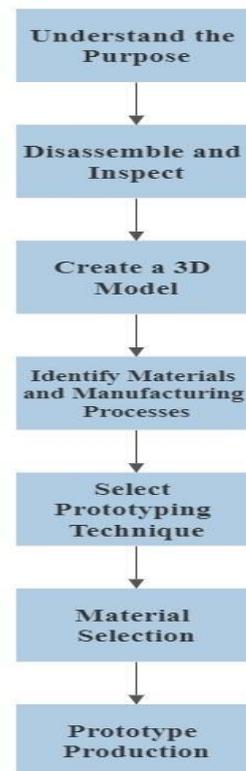
The process starts with a 3D model, which is sliced into thin layers. A 3D printer then builds the object by depositing

material, such as plastic or metal, one layer at a time. This allows for complex designs that would be impossible with conventional manufacturing.

3D printing offers many advantages. It allows for rapid prototyping, minimizes material waste, and enables on-demand manufacturing. This technology is transforming various fields, from engineering and medicine to design and manufacturing.

5. Process

5.1. Methodology



5.2. 3D Scanning of the Component



Figure 5. 3D Scanning of the component

1. Calibrate the 3D scanner to ensure accurate data capture.
2. Place the object on a platform with wrinkled paper for better scanning.
3. Connect the scanner to the computer via a data conversion module.
4. Position the scanner at a 45-degree angle and start scanning while rotating the object.
5. Repeat the scan from different positions to capture the entire component.
6. View the scanned data on the scanner screen or PC, and process it using Calibry Nest software.

5.3. Rendering of 3D Scanned Data

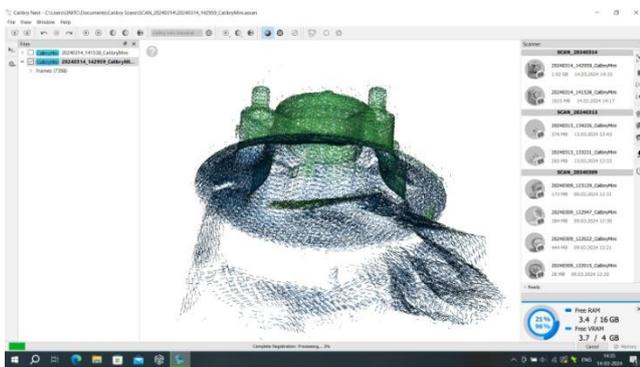


Figure 6. 3D Scanned Data

1. After scanning, you'll get a point cloud, a vast collection of data points representing the object's surface.
2. Rendering is the magic that transforms this point cloud into a visually appealing and realistic image.
3. Rendering software acts like a light choreographer, simulating how light interacts with the 3D model to create a final image, just like a photograph.
4. Calibry appears to be a one-stop shop, handling both 3D scanning and rendering within its software suite.
5. Patience is key! Rendering times depend on your computer's muscle. Free up RAM and use a PC with a powerful processor for a speedier rendering process.
6. To capture the entire object, repeat the scanning and rendering process from multiple angles, ensuring both sides are covered.
7. The final rendered image should closely resemble the original scanned object.

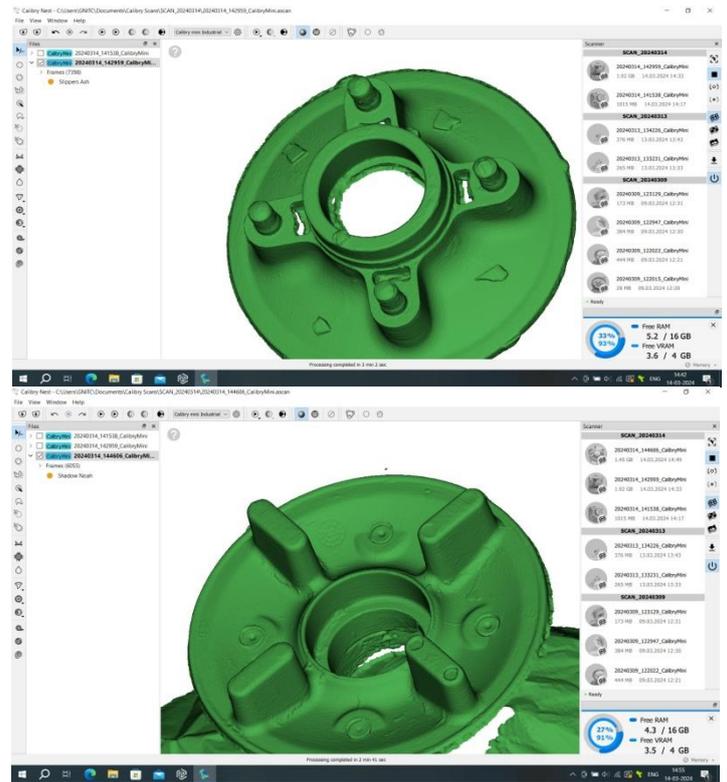


Figure 7. 3D Scanned Data after Rendering

5.4. Merging of 3D Data

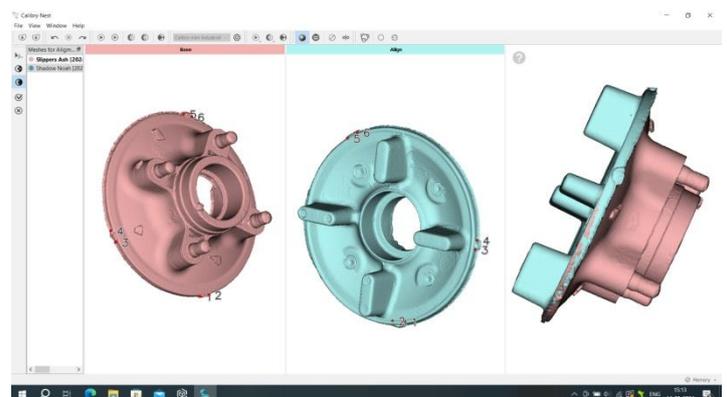


Figure 8. Component after Merging

1. After rendering both sides of the object, you'll need to merge them into a single, complete 3D model.
2. This merging process involves selecting reference points on each side and joining them together.
3. Once merged, you can export the 3D model for further processing.
4. Geomagic software is an option for exporting the model and potentially creating a 2D sketch from the 3D data.
5. The final step is to have a complete 3D model or even a 2D sketch of the scanned component.

5.5. Designing in Geomagic Software

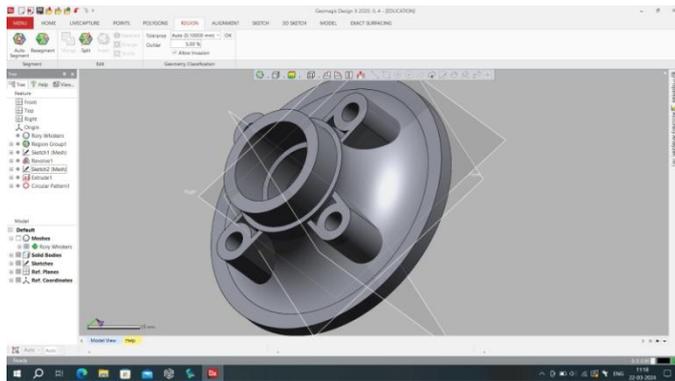


Figure 9. Creating the 3D Component

1. Once you have a complete 3D model, export it to software like Geomagic for further processing.
2. Within Geomagic, use design tools to create a 2D sketch of the desired profile from the 3D model.
3. You can then extrude this 2D profile to transform it back into a 3D component.
4. With the 3D component in Geomagic, make any necessary adjustments to the design.
5. Finally, export the finalized 3D model to 3D printing software for creating a physical prototype.

5.6. Importing into a 3D Printing Software

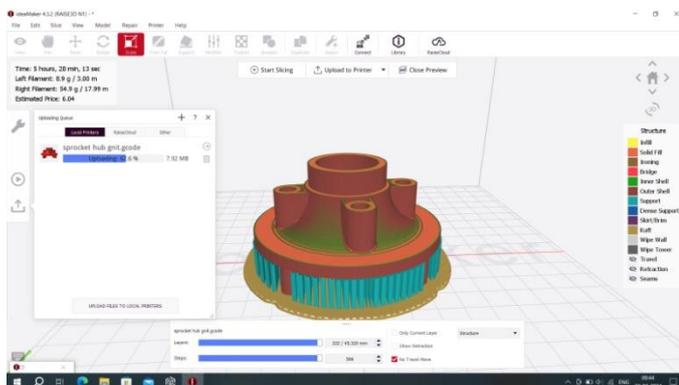


Figure 10. Creating the support structures

1. Import your 3D model into 3D printing software like IdeaMaker.
2. Position and orient the component for optimal printing without damage, ensuring alignment with the printer nozzle.
3. Define printing specifications like scale and material selection.
4. Slice the 3D model into thin layers for the printer to follow.
5. Add supporting structures to the model for stability during printing (these can be removed later).

6. Save and upload the final file to your 3D printer for physical creation.

5.7. 3D Printing

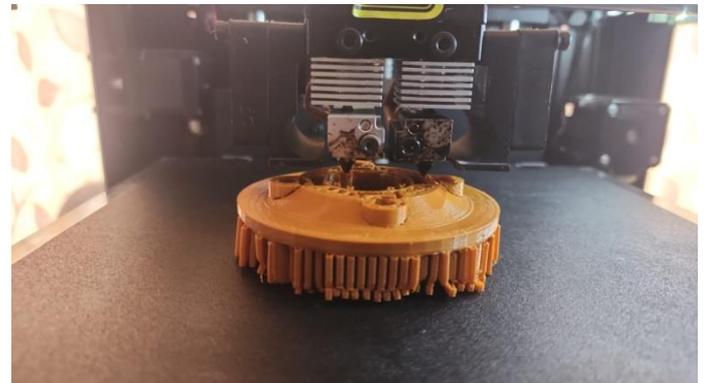


Figure 11. 3D Printing

1. Upload your 3D model and set the printing temperature for both the nozzle and the heatbed on the 3D printer.
2. Initiate the printing process. The printer will likely use FDM (Fused Deposition Modeling) to build the object layer by layer.
3. Monitor the printing closely. Keep the printer closed to avoid contamination, take progress photos, and check for errors. If errors occur, restart the printing process.
4. Once printing is complete, remove the support structures that were added for stability during printing.
5. Take photos of your final 3D printed component.
6. The entire printing process, including removing support structures, may take several hours.

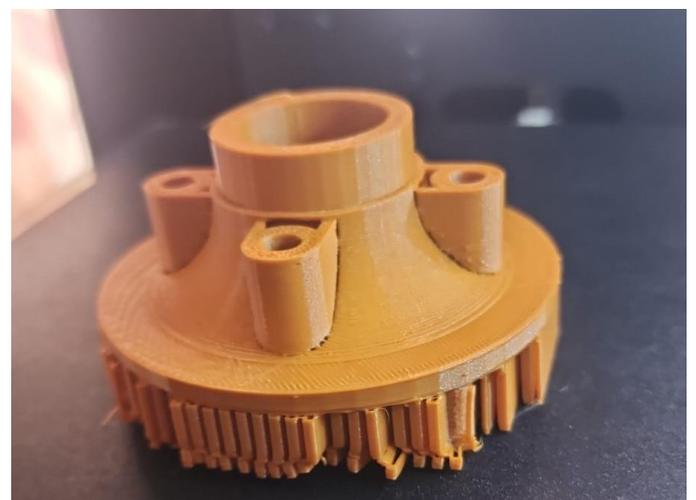


Figure 12. 3D Printed Component with Support Structures

6. Results

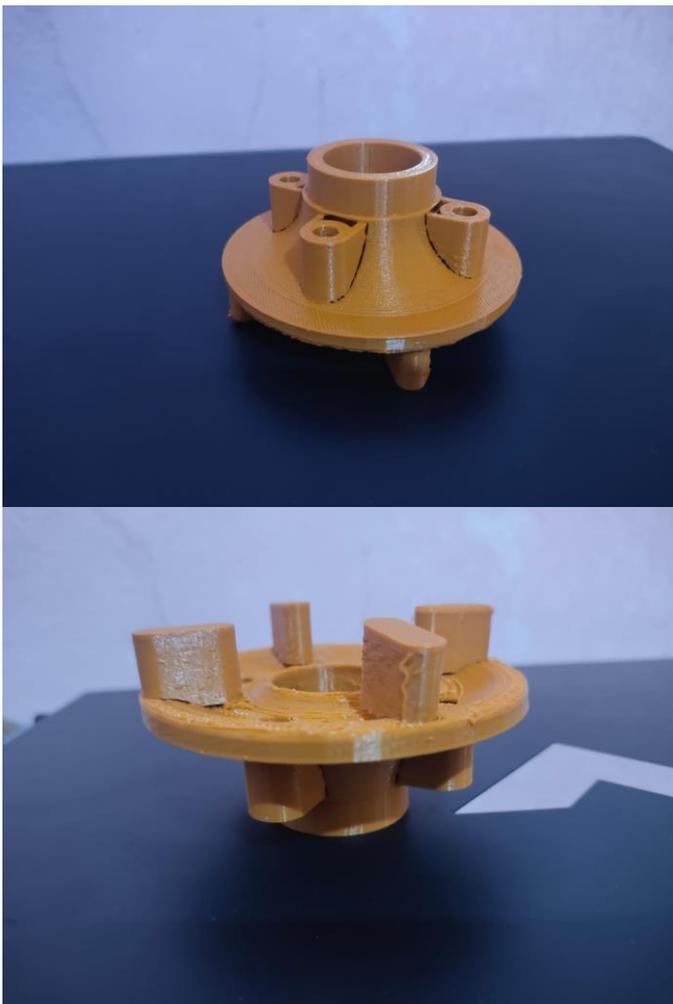


Figure 13. 3D Printed Component

This project aimed to recreate a two-wheeler sprocket hub using 3D technologies. First, a 3D scan of the sprocket hub was captured and processed using Calibry software. This scan data was then converted into a 2D technical drawing and a 3D model using Geomagic software.

Next, the 3D model was optimized for 3D printing by adding support structures and adjusting its design for successful printing. The choice of printing material depended on factors like strength, weight, and the intended use of the prototype sprocket hub. Finally, the printed sprocket hub was evaluated to ensure it met the dimensional requirements of the original component.

7. Conclusion

The project successfully demonstrated that combining 3D scanning, CAD software, and 3D printing is a powerful approach for reverse engineering and prototyping a two-wheeler sprocket hub. The 3D scan captured precise details, and the CAD software created accurate 2D drawings and a 3D

model. The 3D printed replica was useful for dimensional analysis, design validation, and exploring its potential for custom or replacement parts.

This project highlights the potential of 3D printing in the two-wheeler industry for replicating and innovating existing parts. Rapid prototyping allows for faster design iterations and cost-effective development of custom parts. Future research can explore optimizing this approach for various two-wheeler components.

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REFERENCES

1. F. Hansen, E. Pavlakos, E. Hoffman, T. Kanade, R. Reddy, and P. Wright, "PARES: A Prototyping and Reverse Engineering System for Mechanical Parts-on-Demand on the National Network," *Journal of Manufacturing Systems*, vol. 12, no. 4, pp. 269-279
2. A. Kumar, P. K. Jain, and P. M. Pathak, "Reverse Engineering in Product Manufacturing: An Overview," in *DAAAM International Scientific Book 2013*, B. Katalinic and Z. Tekic, Eds. Vienna, Austria: DAAAM International, 2013, pp. 665-678. doi: 10.2507/daaam.scibook.2013.39
3. M. M. Joshi, "Reverse Engineering: An Indispensable Process in Manufacturing," *International Journal of Advanced Engineering Technology*, vol. 7, no. 1, pp. 49-55, 2016.
4. Lima, L., Rocha, F., Melo, P., Cabral Rodrigues, P., "Mobile Device Security Management: Securing and Monitoring Mobile Assets," *IEEE Access*, vol. 6, pp. 72777-72793, 2018.
5. R. Singh and C. Thakur, "Reverse Engineering: A Technique of Software System Security Analysis," *International Journal of Computer Applications*, vol. 136, no. 9, pp. 33-38, 2016.
6. A. D. Little, "Functional analysis for product design: A methodology and case study," M.S. thesis, Dept. Mech. Eng., Massachusetts Institute of Technology, Cambridge, MA, USA, 1996.
7. D. Babb, "Reverse Engineering: An Overview and Its Role in Cyber Security," *International Journal of Advanced Research in Computer Science*, vol. 9, no. 4, pp. 25-30, 2018.
8. K. H. Lee, "Integration of Reverse Engineering and Rapid Prototyping for Faster Product Development," M.S. thesis, Dept. Mech. Eng., University of Wisconsin-Milwaukee, Milwaukee, WI, USA, 1998.
9. M. Fabian, "Application of Reverse Engineering and Rapid Prototyping in Automotive Industry," *Acta Mechanica Slovaca*, vol. 22, no. 1, pp. 37-44, 2018.
10. T.-S. Huang,shin-yuan lin, "Reverse Engineering and Rapid Prototyping for Product Development," *International Journal of Computer Applications*, vol. 175, no. 3, pp. 1-6, 2017.
11. E. Irzmańska and M. Okrasa, "Usage of 3D Scanning for Footwear Fitting," *Fibres & Textiles in Eastern Europe*, vol. 25, no. 4, pp. 134-138, 2017.
12. Tredinnick, R., Brooke, T., Bertram, D., and Smith, G, "3D Scanning for Complex Crime Scene Reconstruction," *Proc. Int. Conf. Cyberworlds*, pp. 47-54, 2013.
13. Lazarević, M., Tabaković, S., and Puzović, R., "Inspection of Parts Produced by Metal Cutting Using 3D Scanning," *Facta Universitatis, Series: Mechanical Engineering*, vol. 18, no. 3, pp. 361-369, 2020.
14. A. Haleem and M. Javaid, "3D Scanning Applications in Medical Field: A Literature-Based Study," *Alexandria Journal of Medicine*, vol. 55, no. 4, pp. 317-328, 2019.
15. K. Maloney, "3D Scanning for the Measurement of Surface Defect Areas," M.S. thesis, Dept. Geol. Eng., Missouri University of Science and Technology, Rolla, MO, USA, 2017.
16. W. Feng et al, Paulino, M., and Lev, "3D Scanning and Geometric Imperfection Analysis of Cylinders," *ThinWalled Structures*, vol. 144, pp. 1-12, 2019.
17. K. Andrews et al, Coughlin, R., and Pan, "3D Scanning: A Novel Method for Measuring Growth in Preterm Infants," *Journal of Perinatology*, vol. 41, no. 5, pp. 844-852, 2021.
18. M. Javaid and A. Haleem, "Current Status and Applications of 3D Scanning in Dentistry," *Clinical Epidemiology and Global Health*, vol. 7, no. 2, pp. 179-186, 2019.
19. L. Chen et al, Zhan, Y., and Wang, X, "Semi-Automatic Laser Scanning and Rock Mass Characterization," *Canadian Geotechnical Journal*, vol. 58, no. 4, pp. 478-492, 2021.
20. J. Zhang et al, W., Shao, Z., and Xu, J, "Road Marking Detection Based on 3D Scanning," *Sensors*, vol. 20, no. 6, pp. 1-20, 2020.
21. W. T. McCann, *The Design and Tuning of Competition Engines*. Haynes Publishing, 1997.
22. D. Vizard, *Tuning the A-Series Engine*. Haynes Publishing, 1998.
23. L. Shepard, *How to Rebuild and Modify Carter/Edelbrock Carburetors*. HP Trade, 1997.
24. B. Fisher, *How to Tune and Modify Automotive Engine Management Systems*. Motorbooks International, 2002.
25. D. Emanuel,David. Weber *Carburetors*. HPBooks, 1998