

Article

Weight Reduction and Structural Optimization of a Face Milling Cutter Using DfAM

Jing-Hua Li ¹ , Hyun-Kyu Kweon ^{2,*}, Goo-Sang Jung ³, Young-Hun Chae ⁴ and Dong-Gyu Kim ⁵¹ Research Institute of Manufacturing and Productivity, Kumoh National Institute of Technology, Gumi 39177, Republic of Korea² Department of Mechanical System, Kumoh National Institute of Technology, Gumi 39177, Republic of Korea³ Conception Inc., Gumi 39370, Republic of Korea⁴ Institute of Mechanical Engineering Technology, Kyungpook National University, Daegu 41566, Republic of Korea⁵ Center for Advanced Cutting Tool and Machining, Daegu Mechatronics & Materials Institute, Daegu 42715, Republic of Korea

* Correspondence: hkkweon@kumoh.ac.kr; Tel.: +82-010-9856-8129

Abstract

This study explores the application of design for additive manufacturing (DfAM) to modify the design of a face milling cutter, with the aim of reducing its weight. Conventional manufacturing methods often limit design flexibility, particularly for hollow shapes and internal channels, while additive manufacturing offers greater design freedom. Using topology optimization, which removes low-stress regions, the face milling cutter's weight was reduced by 36.1%. The face milling cutter was produced using a powder bed fusion (PBF)-based metal three-dimensional printer, followed by material verification, post-processing, and structural analysis. The results confirm the feasibility of weight reduction without compromising structural integrity, demonstrating the potential of DfAM for efficient, high-performance tooling design.

Keywords: DfAM; face milling cutter; lightweight; metal 3D printer

1. Introduction

Additive manufacturing is a method of producing three-dimensional (3D) objects by stacking layers of materials, and it has attracted attention as an innovative technology surpassing conventional manufacturing methods. With the advent of additive manufacturing, appropriate design methods have also emerged to maximize the benefits of 3D printing.

In conventional metal-cutting processes, there are severe restrictions on geometry, making it difficult to implement complex shapes. Although various cutting processes, including 4-axis and 5-axis machining, are available, they still face limitations in producing hollow or highly complex geometries. In contrast, additive manufacturing creates objects by stacking materials, allowing greater geometric freedom, provided appropriate support structures are used. Therefore, there is no concern about unmachinable parts during the design stage.

Additive manufacturing, which is realized through 3D printing technology, differs from traditional manufacturing methods, which typically involve removing material from solid blocks. By stacking layers, additive manufacturing significantly reduces material waste and offers much higher design freedom.

The design for additive manufacturing (DfAM) approach maximizes the advantages of 3D printing technology. It enables a weight reduction in products through topology



Academic Editor: Paolo Renna

Received: 26 May 2026

Revised: 9 July 2026

Accepted: 9 July 2026

Published: 14 July 2026

Copyright: © 2026 by the authors.

Licensee MDPI, Basel, Switzerland.

This article is an open access article distributed under the terms and

conditions of the [Creative Commons](#)[Attribution \(CC BY\) license](#).

optimization and the application of lattice structures. Additionally, DfAM facilitates benefits such as part integration and the incorporation of internal cooling channels.

In modern manufacturing, the milling process is subjected to complex dynamic loading conditions, where cutting tools experience severe cyclic forces and high-speed rotational acceleration. To address these challenges, various research units have investigated the structural and topological optimization of cutting tools. Prior studies have demonstrated that optimizing the mass distribution of tool bodies can significantly enhance dynamic stiffness, suppress machining vibrations, and stabilize cutting force variations, thereby improving surface finish quality and extending tool life [1]. However, conventional manufacturing methods often limit the geometric complexity achievable through topology optimization. This study aims to overcome these limitations by implementing a systematic DfAM-based optimization process for a face milling cutter.

2. Theoretical Background

Additive manufacturing is a method of producing 3D objects by stacking materials (e.g., polymers, ceramics, and metals) in layers and is the manufacturing method used in 3D printing technology. Additive manufacturing has been regarded as an innovative technology that reduces processing steps and enhances product functionality in key industries. Initially used for producing a small number of prototypes, it has evolved into a technology for manufacturing and mass-producing actual components [2]. Recent advancements in metal additive manufacturing have further expanded its application to high-performance industries such as aerospace, automotive, and biomedical engineering, where superior mechanical properties are strictly required [3,4]. Understanding the complex relationship between process parameters, microstructural evolution, and the resulting mechanical behavior is crucial for ensuring the reliability of these metallic components [5,6].

3D printing technology enables the production of products with complex geometries, high precision, high design freedom, and customization capabilities. It can also create parts that were difficult to achieve using conventional manufacturing methods, thereby increasing innovative applications, such as process simplification, production cost reduction, weight reduction, and part integration.

The terms previously used for additive manufacturing, such as rapid prototyping (RP) techniques, were standardized under ASTM F2792 and classified into seven methods according to the stacking technique [7].

DfAM techniques are design strategies that enable the realization of geometries that were previously impossible with conventional processes such as cutting, pressing, and molding [8]. Unlike traditional design rules that focus on manufacturing constraints like tool access and draft angles, DfAM shifts the paradigm toward optimizing functional performance [9]. To effectively implement DfAM, researchers have proposed various design frameworks and unique manufacturing methodologies that account for process-specific constraints such as build orientation and the necessity of support structures [10,11]. Furthermore, DfAM principles can be extended to assembly-level design, facilitating the consolidation of multiple components into a single monolithic part, which inherently eliminates secondary joining operations [12]. Products designed using DfAM techniques can improve performance and eliminate the need for assembly or welding by achieving weight reduction, part integration, and the implementation of internal curved channels.

Topology optimization is one of the DfAM techniques. As shown in Figure 1, it is applied to reduce weight, maximize stiffness, and improve heat dissipation based on structural or thermal analysis [13]. The mathematical foundation of topology optimization allows for the optimal distribution of materials within a designated design space under specific load conditions [14]. With the maturation of density-based and level-set optimiza-

tion algorithms, it has become a powerful tool for generating organic, high-performance structures that are uniquely manufacturable via 3D printing [15]. In particular, integrating manufacturing constraints directly into the optimization loop ensures that the generated geometries avoid excessive overhangs or unmovable powder traps [16]. This approach has been widely adopted in lightweight structural design to achieve substantial mass reduction without sacrificing structural integrity [17].

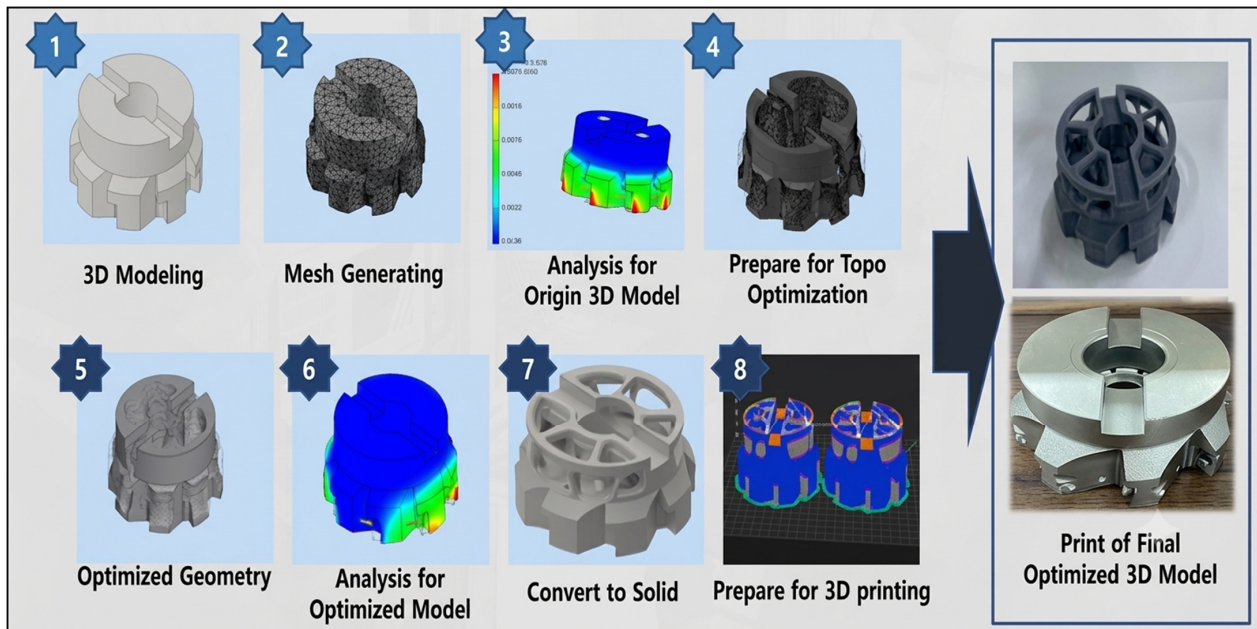


Figure 1. Summary of the DfAM application process.

Lattice geometry, also known as the lattice structure, is a design method that focuses on 3D printing technology's capability to produce complex geometries [18]. The systematic categorization and design workflows of lattice structures have been widely studied to unlock their full potential in industrial applications [19]. These cellular materials can be classified into strut-based, sheet-based, or cluster-based configurations, each exhibiting distinct mechanical behaviors under compressive or tensile loading [20]. Triply periodic minimal surface (TPMS) structures, a prominent class of sheet-based lattices, have gained significant attention due to their continuous curvature and excellent energy absorption capabilities [21]. Under compressive loads, selective laser-melted metallic lattices demonstrate highly predictable deformation mechanisms, making them ideal for impact resistance and structural damping [22].

Conventional heat exchangers were manufactured by stacking multiple plates in layers. Applying 3D printing technology significantly simplifies manufacturing processes through component integration and enables the development of high-efficiency structural components using advanced lattice geometry [23]. This method is also applied to cutting processes to reduce the weight of face milling cutters while maintaining or improving performance in high-speed environments [24,25]. Implementing appropriate design strategies is essential for driving the industrial adoption of additive manufacturing, particularly when transitioning from academic concepts to real-world mechanical components [26].

Currently, face milling cutters used in the milling process have complex geometries, making manufacturing quite challenging. Continuous research has been conducted to improve their cutting performance [27,28]. Accurate modeling of metal-cutting mechanics and tool vibrations is critical for mitigating chatter and ensuring surface quality during high-speed machining operations [29]. To address these challenges, advanced research has

focused on the design and additive manufacturing of optimized milling tools, demonstrating that custom-tailored internal features can significantly enhance damping and cooling efficiency. Consequently, the integration of DfAM principles with modern high-performance machine tools represents a vital frontier in advanced manufacturing technology [30,31].

3. DfAM-Based Face Milling Cutter Printing

3.1. DfAM Modeling

The target face milling cutter for the application of DfAM in this study's experiment is the TFM90AP 8100-32R-17 produced by TaeguTec (Daegu, Republic of Korea). Its size is $\varnothing 100 \times 50$ mm, and it weighs 1.5 kg. The applied insert is the APKT 1705 PER-EM (TaeguTec, Daegu, Republic of Korea). The face milling cutter was produced using a metal 3D printer CSLM-250 (WinforSys, Yongin, Republic of Korea).

Prior to the experiment, 3D modeling of the face milling cutter was performed through 3D scanning and reverse engineering for the application of DfAM, as shown in Figure 2. After modeling in .stl format via 3D scanning, a modeling file in .stp format was created through reverse engineering. In the experiment, the .stp file was used except for the lattice geometry.

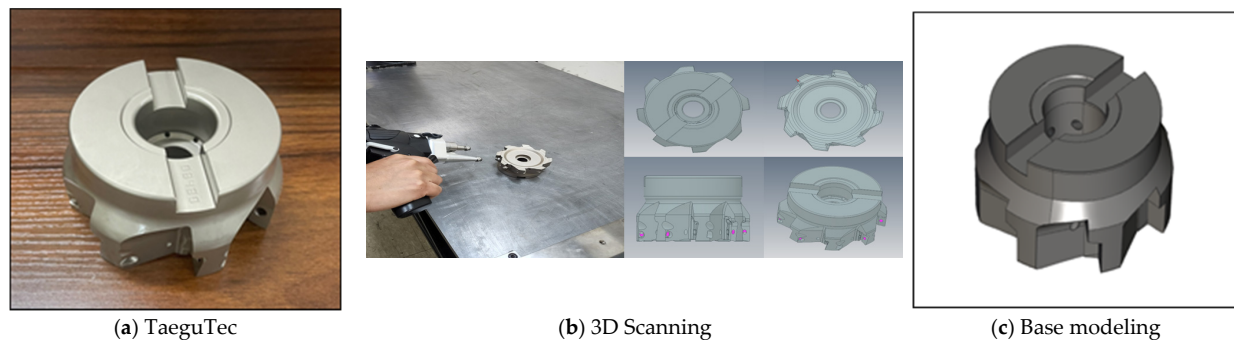


Figure 2. 3D modeling of the face milling cutter.

Based on the analysis results of the 3D modeling file of the face milling cutter using ANSYS Workbench 2023 R2, parts with low stress were removed, and the weight reduction target was set to approximately 30%. Figure 3 shows the model obtained through reverse engineering, along with the boundary and load conditions applied in DfAM. Figure 3a shows the mesh sizing for topology optimization. To ensure the reliability of the structural analysis results, they were generated uniformly using Tetrahedron elements. Figure 3b shows the mounting conditions of the face milling cutter on the machine, which were used as constraints. A fixed-support condition was applied to the contact area in a manner where it is mounted on the machine's spindle taper, and Figure 3c highlights the rotational loads applied to each edge, representing the loads received by the face milling cutter fixed to the spindle taper during actual machining; specifically, a peak cutting load value of 150 kgf/mm² based on high-strength specific cutting resistance was uniformly distributed across the active insert pocket seats. However, several constraints existed because the face milling cutter rotates at high speeds and is used for precision machining. When solid portions of the face milling cutter were removed, the uppermost and outermost surfaces had to be maintained at a thickness of at least 1 mm, as shown in Figure 4; this modification could not affect the internal channels. Additionally, the solid portions around the insert fastening were not removed. In Figure 4a, a condition was added to maintain the shape of the top and the part connecting the spindle taper, as the dimensions must be maintained when the face milling cutter is mounted onto the machine. In Figure 4b, a condition was also added to maintain the corresponding part in order to secure an internal passage for

spraying cooling water while the face milling cutter rotates. In Figure 4c, a condition was added to maintain the shape of each edge, indicated by the dashed circles, to ensure that a connection existed when mounting the insert required for the face milling cutter.

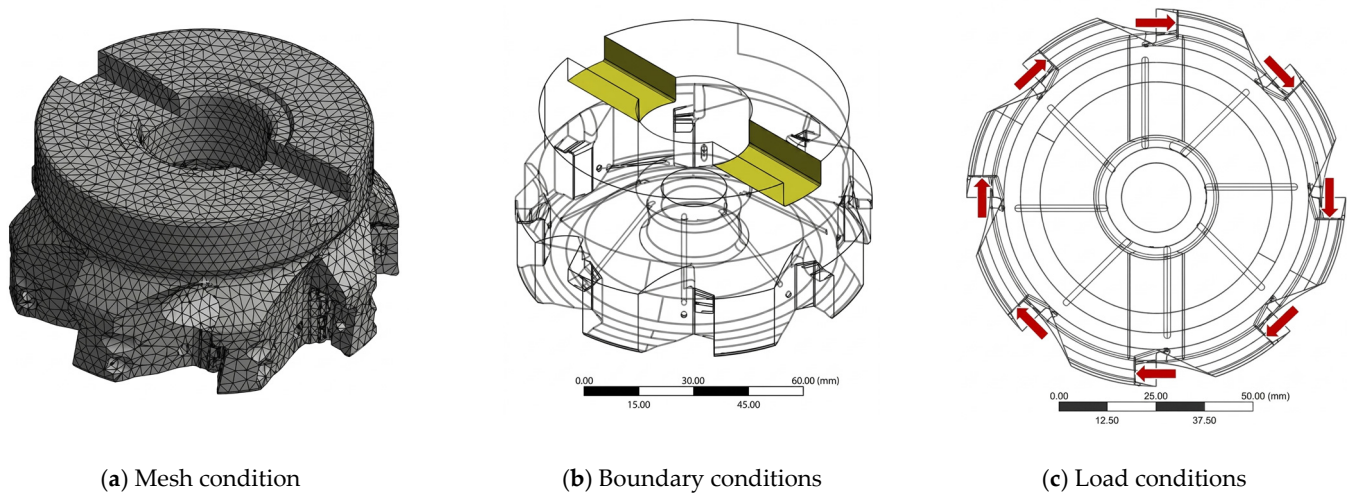


Figure 3. Conditions of the topology optimization load analysis.

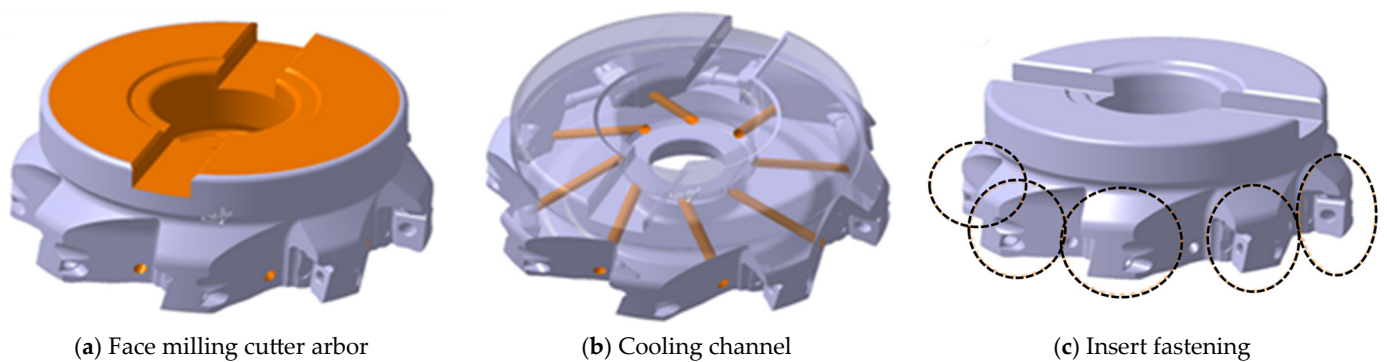


Figure 4. Conditions of the topology optimization geometry.

When the weight reduction rate was examined based on the volume after DfAM, the volume was reduced by 36.1%, from 217,645.009 mm³ to 139,034.125 mm³, as shown in Figures 5 and 6.

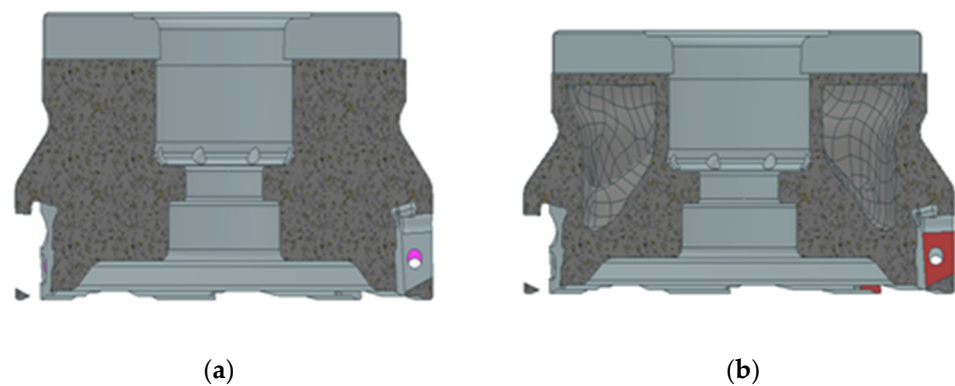


Figure 5. Comparison of cross-sections after applying DfAM. (a) Existing face milling cutter; (b) After applying DfAM to the face milling cutter.

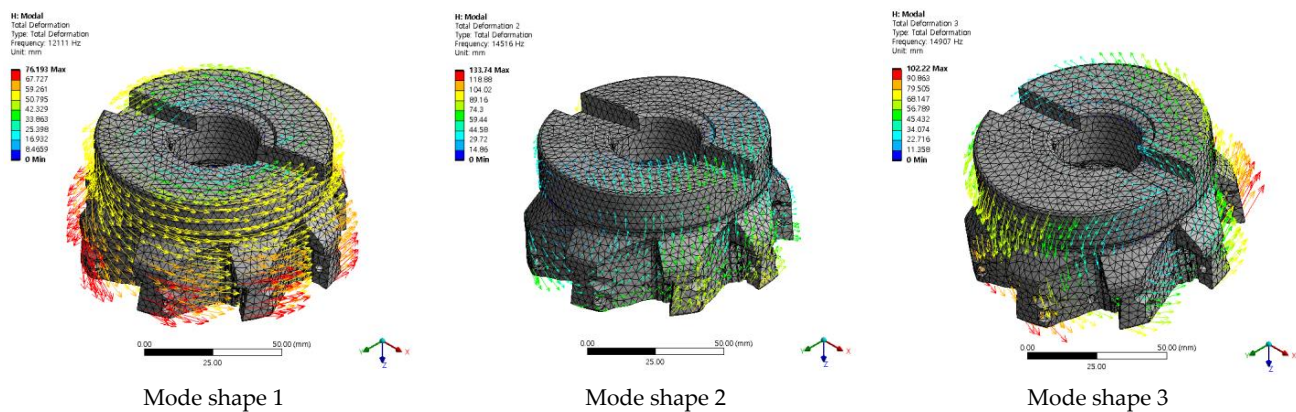


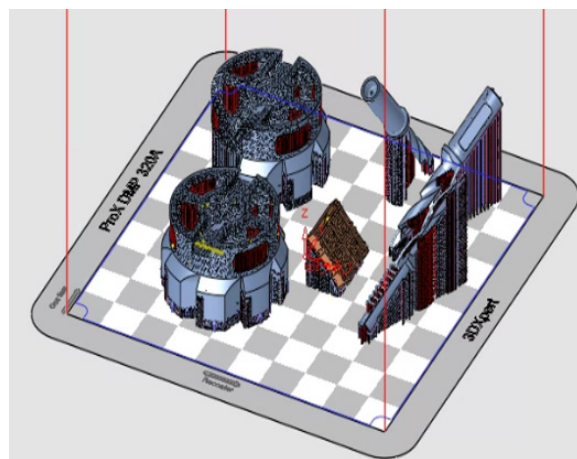
Figure 6. Mode shape results of the face milling cutter.

For the face milling cutter designed based on DfAM, structural vibration analysis was conducted using the boundary conditions applied in DfAM. The mode shape geometry could be confirmed. The simulation results will be comprehensively compared with the actual experimental data in the subsequent section.

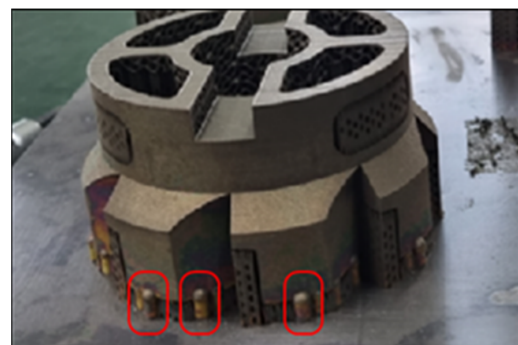
3.2. Metal 3D Printing

Because the 3D printing process is difficult and not commercialized for the H13 material used in the original face milling cutter, maraging steel was selected as an alternative material. Specifically, H13 tool steel is highly susceptible to micro-cracking during laser powder bed fusion (PBF) due to high thermal stresses and rapid solidification rates [31]. In contrast, maraging steel, featuring an extremely low carbon content, exhibits excellent printability and weldability, while post-printing aging treatment allows it to attain mechanical properties comparable to those of H13 [32,33]. To verify whether the properties of the 3D-printed maraging steel matched those of H13, specimen analysis and heat treatment condition comparisons were conducted before metal 3D printing of the DfAM face milling cutter.

To prevent shrinkage during the printing process, shrinkage reinforcement was applied, as shown in Figure 7. Properties were evaluated under seven heat treatment conditions. These included the as-built condition (A) and six other conditions (B to G) involving different heat treatment durations following a solution treatment at 815 °C for 1 h, as shown in Table 1. The specimen size was $\varnothing 10 \times 100$ mm, and tensile strength, yield strength, elongation, and Rockwell hardness (HRC) were measured and compared.



(a) Output build



(b) Shrinkage reinforcement

Figure 7. Design for shrinkage reinforcement.

Table 1. Property evaluation conditions for metal 3D printing specimens.

Category	Solution Treatment	Heat Treatment	
		Temperature	Duration
A		As-built	
B	815 °C for 1 h	490 °C	1 h
C	815 °C for 1 h	490 °C	6 h
D	815 °C for 1 h	490 °C	10 h
E	815 °C for 1 h	530 °C	1 h
F	815 °C for 1 h	530 °C	6 h
G	815 °C for 1 h	530 °C	10 h

Based on the property evaluation results of the metal 3D-printed maraging steel specimens, the as-built condition (A) exhibited a tensile strength of approximately 1170 MPa, a yield strength of approximately 1050 MPa, an elongation of approximately 15%, and a hardness of approximately 35 HRC. Condition B showed a tensile strength of approximately 1880 MPa, a yield strength of approximately 1820 MPa, an elongation of approximately 4.0%, and a hardness of approximately 50 HRC. Condition C showed a tensile strength of approximately 1970 MPa, a yield strength of approximately 1900 MPa, an elongation of approximately 5.5%, and a hardness of approximately 50 HRC. Condition D exhibited a tensile strength of approximately 1950 MPa, a yield strength of approximately 1880 MPa, an elongation of approximately 4.0%, and a hardness of approximately 50 HRC. Condition E exhibited a tensile strength of approximately 1940 MPa, a yield strength of approximately 1860 MPa, an elongation of approximately 5.0%, and a hardness of approximately 50 HRC. Condition F showed a tensile strength of approximately 1710 MPa, a yield strength of approximately 1610 MPa, an elongation of approximately 7%, and a hardness of approximately 47 HRC. Condition G exhibited a tensile strength of approximately 1600 MPa, a yield strength of approximately 1500 MPa, an elongation of approximately 11%, and a hardness of approximately 47 HRC.

When the results before and after heat treatment were compared, the tensile strength increased by 35–67% and the hardness value increased by 34–45% after heat treatment. However, the elongation metric decreased by 26–74%. Table 2 presents the property evaluation results for the metal 3D-printed maraging steel specimens. The tensile strength decreased, while the elongation value increased as the heat treatment duration at 530 °C increased.

Table 2. Mechanical property evaluation results of the metal 3D-printed specimens.

Category	Tensile Strength (MPa)	Yield Strength (MPa, 0.2% Offset)	Elongation (%)	Rockwell Hardness (HRC)
A	1170	1050	15	35
B	1880	1820	4	50
C	1970	1900	5.5	50
D	1950	1880	4	50
E	1940	1860	5	50
F	1710	1610	7	47
G	1600	1500	11	47

The highest properties were observed under heat treatment condition C. Therefore, the heat treatment process was performed under condition C after the 3D printing of the DfAM face milling cutter. Figures 8–10 show the distribution of the property evaluation results for the metal 3D-printed maraging steel specimens.

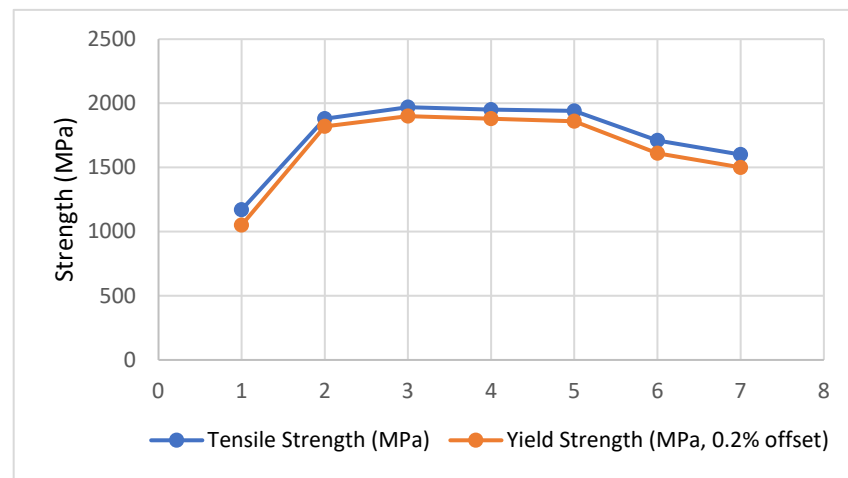


Figure 8. Tensile strength distribution of the metal 3D printing specimens.

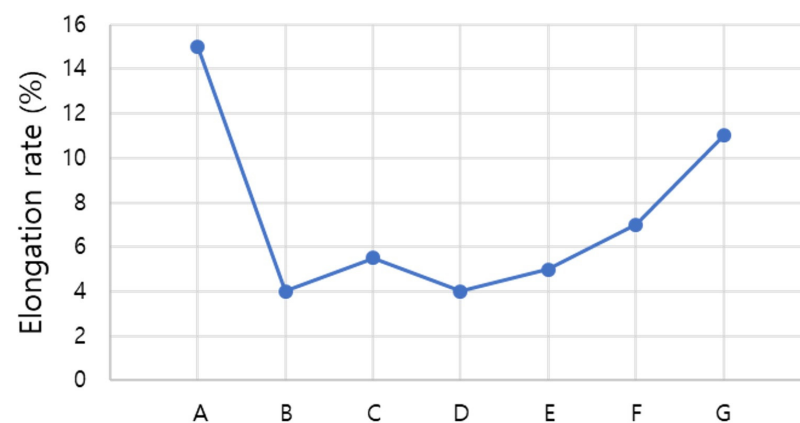


Figure 9. Elongation distribution of the metal 3D printing specimens.

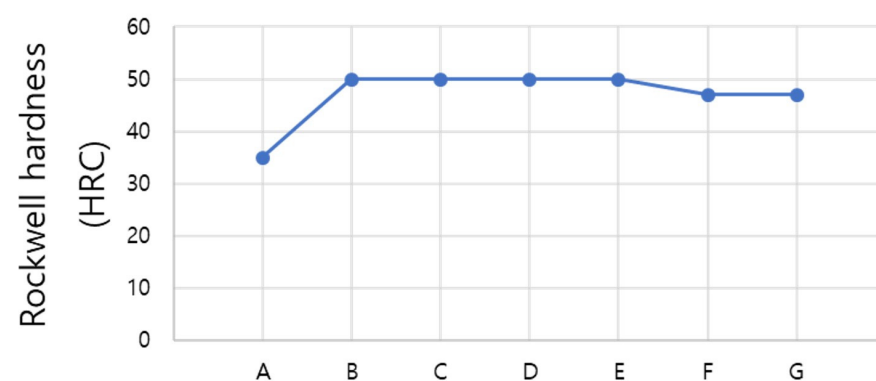


Figure 10. Hardness distribution of the metal 3D printing specimens.

After the DfAM of the face milling cutter and the verification of the 3D printing material were completed, the DfAM face milling cutter model was printed using the CSLM-250, a metal 3D printer. The printer adopts the powder bed fusion (PBF) method, which uses a 400 W fiber laser.

For the final completion of the printed DfAM face milling cutter, the precision and surface roughness of the face milling cutter were improved through post-processing. This enabled the actual testing and insert mounting of the face milling cutter. Figure 11 shows the DfAM face milling cutter after completion of post-processing following metal 3D printing.

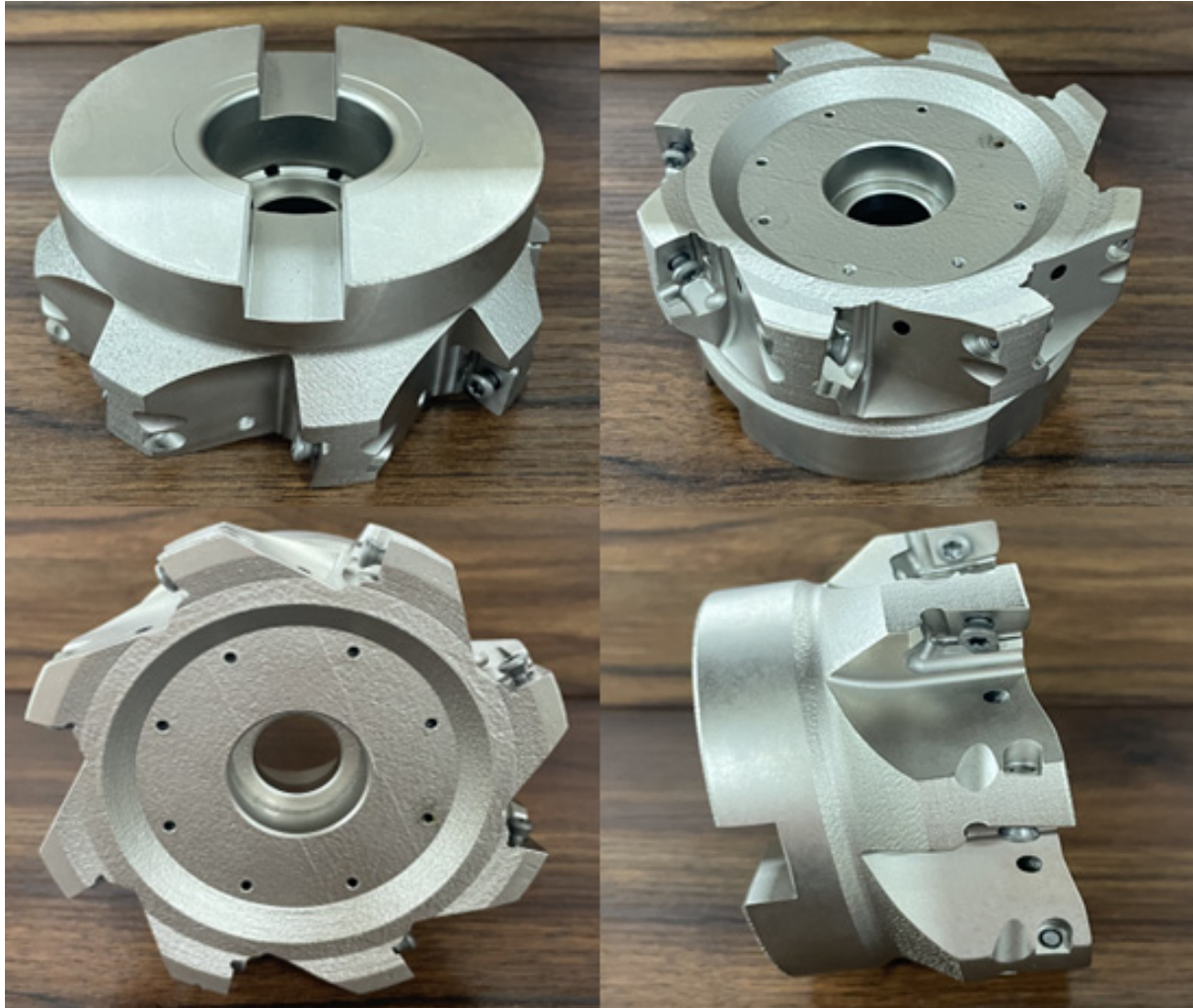


Figure 11. Photographs of the final metal 3D printing DfAM face milling cutter.

As shown in Figure 12, to evaluate the structural dynamics of the newly designed face milling cutter, an FRF (Frequency Response Function) test was conducted on the assembled face milling cutter and spindle tool holder structure. It should be noted that a discrepancy exists between the boundary conditions of the numerical simulation and the physical experiment. The fixed support constraint applied in the finite element model is a modeling simplification restricted to the cutter–holder clamping interface to isolate the local elastic behavior of the cutter head. Conversely, the experimental setup represents the suspended cutter–holder assembly under approximately free–free boundary conditions using a flexible clamping band to minimize environmental compliance. While this introduces a structural limitation in directly cross-comparing absolute values due to the unmodeled spindle mass and fixture compliance, the experimental results still serve as a valuable reference to evaluate the relative structural modes. As summarized in Table 3, the experimental FRF revealed that the first natural frequency occurs in a high-frequency region exceeding 10 kHz. Specifically, the experimental and simulated first natural frequencies were 12,111 Hz and 11,397 Hz, respectively. Despite the simplified boundary conditions and the inherent

differences in the setup, they demonstrated a reasonable agreement with a relative error of approximately 5.9%, adequately supporting the reliability of the finite element model. Furthermore, since these high-frequency modes are equivalent to or higher than those of conventional reference cutters, it ensures that the newly manufactured DfAM face milling cutter possesses sufficient dynamic stiffness. Consequently, it can be concluded that the cutter ensures structural safety and significantly minimizes the risk of resonance within typical machining frequency ranges.



Figure 12. Natural frequency measurement.

Table 3. Comparison between the simulation and FRF results.

Mode	Simulation Frequency of Target (Hz)	FRF Frequency of Target (Hz)
1	12,111	11,397
2	14,516	14,469
3	14,907	14,844
4	16,363	16,744
5	18,466	18,968
6	18,794	19,280
7	20,225	21,273
8	21,154	21,427
9	25,195	27,590
10	26,554	27,804

4. Conclusions

In this study, the weight of the existing face milling cutter was reduced by approximately 36.1% through the application of the DfAM technique. The face milling cutter was then produced using a metal 3D printer and underwent post-processing and testing for practical use.

1. Parts with low stress were sequentially removed to achieve a weight reduction of approximately 36.1%. The structural stability of the lightweight face milling cutter was confirmed through structural analysis.

2. Maraging steel was used for the face milling cutter's production. Its tensile strength, elongation, and hardness were evaluated under different printing conditions. After 3D printing, the face milling cutter was subjected to post-processing, and the insert was mounted.

3. Vibration analysis and the FRF test were conducted to assess structural stability. The comparison of results showed that the first natural frequencies were higher than 10 kHz, and higher modes exhibited similar tendencies. These results confirm the stability of the face milling cutter printed with DfAM.

This study successfully demonstrates the stability and effectiveness of DfAM for face milling cutters, confirming that the design freedom offered by additive manufacturing significantly surpasses that of conventional manufacturing methods.

Author Contributions: Conceptualization, J.-H.L. and G.-S.J.; methodology, J.-H.L.; software, J.-H.L.; validation, J.-H.L., Y.-H.C. and D.-G.K.; formal analysis, J.-H.L. and D.-G.K.; investigation, J.-H.L. and G.-S.J.; resources, G.-S.J. and H.-K.K.; data curation, J.-H.L.; writing—original draft preparation, J.-H.L.; writing—review and editing, H.-K.K.; visualization, J.-H.L.; supervision, H.-K.K.; project administration, H.-K.K.; funding acquisition, H.-K.K. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Technology Innovation Program (RS-2024-00418742, Development of an all-in-one 3D printer to manufacture freeform secondary batteries with a dimensional accuracy of less than 500 μm) funded by the Ministry of Trade, Industry and Energy (MOTIE, Korea).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available in the article.

Conflicts of Interest: Author Goo-Sang Jung was employed by the company Conception Inc. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

3D	Three-Dimensional
DfAM	Design For Additive Manufacturing
FRF	Frequency Response Function
HRC	Rockwell Hardness
PBF	Powder Bed Fusion
RP	Rapid Prototyping
TPMS	Triply Periodic Minimal Surface

References

- Denkena, B.; Krüger, M.; Schindler, J. Topology optimization of milling tools for vibration reduction in high-performance cutting. *J. Manuf. Process.* **2020**, *56*, 412–421. [[CrossRef](#)]
- Lee, K.-O.; Lim, B.; Kim, D.-J.; Hong, M.; Lee, K. Technology Trends in Additively Manufactured Small Rocket Engines for Launcher Applications. *J. Korean Soc. Propuls. Eng.* **2020**, *24*, 73–82. [[CrossRef](#)]
- Gibson, I.; Rosen, D.; Stucker, B. *Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing*, 3rd ed.; Springer: New York, NY, USA, 2021; pp. 115–140.
- Frazier, W.E. Metal additive manufacturing: A review. *J. Mater. Eng. Perform.* **2014**, *23*, 1917–1928. [[CrossRef](#)]

5. DebRoy, T.; Wei, H.L.; Zuback, J.S.; Mukherjee, T.; Elmer, J.W.; Milewski, J.O.; Beese, A.M.; Wilson-Heid, A.; De, A.; Zhang, W. Additive manufacturing of metallic components—Process, structure and properties. *Prog. Mater. Sci.* **2018**, *92*, 112–224. [\[CrossRef\]](#)
6. Herzog, D.; Seyda, V.; Wycisk, E.; Emmelmann, C. Additive manufacturing of metals. *Acta Mater.* **2016**, *117*, 371–392. [\[CrossRef\]](#)
7. Hong, M.P.; Sung, J.H.; Kim, S.Y. Research trends and issues in metal additive manufacturing. *Trans. Mater. Process.* **2022**, *31*, 309–328. [\[CrossRef\]](#)
8. Yang, M.S.; Jang, J.S.; Kim, D.H.; Sung, J.H.; Kim, J.T.; Cho, Y.C.; Lee, J.W. Node part development of vehicle body with space frame using design technology for additive manufacturing. *J. Korean Soc. Manuf. Process Eng.* **2020**, *19*, 45–52. [\[CrossRef\]](#)
9. Thompson, M.K.; Moroni, G.; Vaneker, T.; Fadel, G.; Campbell, R.I.; Gibson, I.; Bernard, A.; Schulz, J.; Graf, P.; Ahuja, B.; et al. Design for Additive Manufacturing: Trends, opportunities, considerations, and constraints. *CIRP Annals.* **2016**, *65*, 737–760. [\[CrossRef\]](#)
10. Ponche, R.; Hascoet, J.Y.; Kerbrat, O.; Mognol, P. A new global approach to design for additive manufacturing. *Virtual Phys. Prototyp.* **2012**, *7*, 93–105. [\[CrossRef\]](#)
11. Rosen, D.W. Design rules and methods for additive manufacturing. In Proceedings of the 18th Annual Solid Freeform Fabrication Symposium, Austin, TX, USA, 6–8 August 2007; pp. 586–597.
12. Laverne, F.; Segonds, F.; Anwer, N.; Le Coq, M. Assembly Design for Additive Manufacturing (ADAM): A creative method to support product innovation. *Int. J. Adv. Manuf. Technol.* **2015**, *81*, 1597–1611. [\[CrossRef\]](#)
13. Park, K. Development of Functional Parts Using Design for Additive Manufacturing. *Korean Soc. Mech. Eng.* **2021**, *2021*, 30.
14. Bendsoe, M.P.; Sigmund, O. *Topology Optimization: Theory, Methods, and Applications*; Springer: Berlin/Heidelberg, Germany, 2003; pp. 1–50.
15. Sigmund, O.; Maute, K. Topology optimization approaches: A reconstruction-based review. *Struct. Multidiscip. Optim.* **2013**, *48*, 1031–1055. [\[CrossRef\]](#)
16. Brackett, D.; Ashcroft, I.; Hague, R. Topology optimization for additive manufacture. In Proceedings of the 22nd Annual Solid Freeform Fabrication Symposium, Austin, TX, USA, 8–10 August 2011; pp. 348–362.
17. Emmelmann, C.; Scheinermann, P.; Munsch, M.; Seyda, V. Laser additive manufacturing of modified structures for lightweight design. *Phys. Procedia* **2011**, *12*, 364–368. [\[CrossRef\]](#)
18. Lee, D.K.; Park, B.Y. A case study on the sustainable development for a stanchion of recreational crafts based on the design for additive manufacturing using a FFF-type 3D printer. *J. Soc. Nav. Archit. Korea* **2021**, *58*, 294–302. [\[CrossRef\]](#)
19. Kim, J.H.; Yoo, D.J. A design and fabrication method of new compact heat exchangers using triply periodic minimal surface. *J. Korean Soc. Precis. Eng.* **2020**, *37*, 509–518. [\[CrossRef\]](#)
20. Tamburrino, F.; Graziosi, S.; Bordegoni, M. The design process of lattice structures for additive manufacturing: Literature review and future trends. *Des. Sci.* **2018**, *4*, e16. [\[CrossRef\]](#)
21. Al-Ketan, O.; Rowshan, R.; Abu Al-Rub, R.K. Topology-mechanical property relationship of 3D printed strut, sheet, and cluster-based BI-continuous cellular materials. *Addit. Manuf.* **2018**, *19*, 167–183. [\[CrossRef\]](#)
22. Yan, C.; Hao, L.; Hussein, A.; Young, P. Ti-6Al-4V triply periodic minimal surface structures manufactured by selective laser melting for tissue engineering. *Procedia CIRP* **2012**, *5*, 251–255. [\[CrossRef\]](#)
23. Leary, M.; Mazur, M.; Elambasseril, J.; McMillan, M.; Chirent, T.; Sun, S.; Brandt, M. Selective laser melting (SLM) of AlSi10Mg lattice structures: Structural performance under compressive loading. *Mater. Des.* **2016**, *98*, 134–149. [\[CrossRef\]](#)
24. Kim, S.G.; Heo, E.Y.; Lee, H.G.; Park, J.J.; Kim, D.W. NC machining load adaptive control using tool feed rates. *J. Korean Soc. Precis. Eng.* **2022**, *39*, 169–177. [\[CrossRef\]](#)
25. Hwang, J.-D.; Jeong, Y.-G. Study on the Development of Multi-Tasking 5-Axis Machining for Insert Type Milling Cutter. In *Proceedings of the Korean Society of Machine Tool Engineers Conference*; The Korean Society of Manufacturing Technology Engineers: Seoul, Republic of Korea, 2004; pp. 21–26.
26. Jung, Y.J. Experimental Study on the Effect of Milling Cutter Setting Method on Surface Roughness. Master's Thesis, Ajou University, Suwon, Republic of Korea, 2021.
27. Kim, J.H.; Kim, H.S. A Study About Character of Tool Wear and Chip on the Face Milling Cutter to Minimize Resultant Cutting Force. *KSMTE* **2000**, *9*, 72–79.
28. Klahn, C.; Leuteneker, B.; Meboldt, M. Design strategies for the industrial application of additive manufacturing. *Procedia CIRP* **2015**, *36*, 230–235. [\[CrossRef\]](#)
29. Altintas, Y. *Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design*, 2nd ed.; Cambridge University Press: Cambridge, UK, 2012; pp. 75–120.
30. Lopez de Lacalle, L.N.; Lamikiz, A. *Machine Tools for High Performance Machining*; Springer: London, UK, 2009; pp. 180–215.
31. Yan, L.; Chen, X.; Li, W. Microstructure and mechanical properties of H13 tool steel fabricated by selective laser melting. *Mater. Sci. Eng. A* **2017**, *684*, 420–428.

32. Tan, C.; Zhou, K.; Ma, W.; Zhang, P. Microstructure and mechanical properties of maraging steel 300 processed by selective laser melting. *Mater. Sci. Eng. A* **2017**, *703*, 311–320.
33. Jelis, E.; Clements, M. Additive manufacturing of tool steels: A review of metallurgical challenges and properties. *J. Mater. Eng. Perform.* **2019**, *28*, 4512–4525.

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.