

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SHENZHEN TUOZHU TECHNOLOGY CO., LTD.,
Petitioner

v.

STRATASYS, INC.
Patent Owner.

IPR2025-00438
U.S. PATENT NO. 10,569,466

DECLARATION OF DR. DENIS R. CORMIER

TABLE OF CONTENTS

I.	Introduction	1
A.	Qualifications and Experience	1
B.	Compensation.....	3
C.	Scope of Work and Materials Considered	4
II.	The Challenged Claims of the '466 Patent.....	5
III.	Level of Ordinary Skill in the Art	8
IV.	Legal Standards	10
A.	Legal Standard for Claim Construction	10
B.	Legal Standard for Prior Art	14
C.	Legal Standard for Patentability.....	15
1.	Anticipation and Inherency.....	15
2.	Obviousness	16
V.	The '466 Patent and the Challenged Claims.....	21
A.	Summary of the '466 Patent (EX1001).....	21
B.	Summary of Prosecution History of the '466 Patent (EX1002)	27
VI.	Summary of Petitioner's Grounds	28
VII.	Ground 1A: Claims 1-5, 7-13, 16, 18, and 20 Would Not Have Been Obvious Over Loughran (EX1004) and Dubois (EX1005).....	29
A.	Overview of <i>Loughran</i> (EX1004).....	29
B.	Overview of <i>Dubois</i> (EX1005)	32
C.	No Motivation to Combine <i>Loughran</i> and <i>Dubois</i>	33
1.	Petitioner's "predictable results" theory does not supply the required motivation to combine	36
D.	Ground 1A Does Not Render Claim 1 Unpatentable.....	41
1.	Petitioner's element 1[f] theory fails because Loughran teaches printer- side dynamic adjustment based on server-provided material information, not	

the claimed receipt of client-selected operational parameters used to control the printer during fabrication.41

2. Dubois does not cure the defect because Dubois’s “optimum values of printing parameters” are determined within the printer-side data processing unit/database, not received from a client as selected operational parameters.44

E. Ground 1A Does Not Render Dependent Claims 2-5, 7-13, 16, 18, and 20 Unpatentable45

1. Claim 5.....45

VIII. Ground 1B: Claims 1-5, 7-13, 16, 18, and 20 Would Not Have Been Obvious Over Loughran (EX1004), Dubois (EX1005), and Jazayeri (EX1010)...49

A. Overview of *Jazayeri* (EX1010)49

B. Jazayeri Is Not Analogous Art50

C. No motivation to combine references in Grounds 1A (*Loughran* and *Dubois*) and 1B (*Jazayeri*).....55

1. Petitioner’s asserted motivation.....55

2. Loughran already provides the “networked job submission” concept Petitioner attributes to Jazayeri55

3. Jazayeri targets a different printing paradigm than Loughran’s SFF fabrication-job workflow56

4. The proposed overlay is in tension with the printer-side parameter-control teachings of Loughran and Dubois.....56

5. Petitioner’s stated “benefits” are generic to cloud printing and do not provide a reason to modify Loughran’s SFF system in the manner proposed 57

D. Ground 1B Does Not Render Claim 1 Unpatentable.....58

E. Ground 1B Does Not Render Dependent Claims 2-5, 7-13, 16, 18, and 20 Unpatentable59

IX. Ground 2: Claim 19 Would Not Have Been Obvious Over Devos (EX1008) 60

A. Overview of *Devos* (EX1008).....60

B. Ground 2 Does Not Render Claim 19 Unpatentable63

1. Petitioner’s element 19[e] theory hinges on recharacterizing Devos’s “powder settling coefficients” as the claimed “support structure requirement” 64

2. Petitioner’s theory fails because Devos does not disclose any claimed “support structure requirement,” nor any other element-19[e] enumerated parameter.....65

3. Petitioner’s “implement Devos to generate a support-structure parameter” theory is an expert-driven redesign untethered to Devos66

4. Conclusion71

X. Ground 3A: Claims 1, 3-5, 7, 9-11, 19, and 20 Would Not Have Been Obvious Over *Menchik* (EX1009).....71

A. Overview of *Menchik* (EX1009).....71

B. Overview of *Dahlin* (EX1011).....72

C. Ground 3A Does Not Render Claim 1 Unpatentable.....73

1. *Menchik* does not teach element 1[b] because claim 1’s “client” is distinct from the printer’s controller, and *Menchik*’s “controller 105” is a printer-controller component—not a client device that sends a fabrication request74

2. *Menchik* does not teach element 1[e] because it does not disclose “providing the data from the tag to the client over the network”78

3. *Menchik* does not teach element 1[f] because the asserted “operational parameters” are not “receiv[ed] ... from the client selected for use” as claim 1 requires.....78

D. Ground 3A Does Not Render Claim 19 Unpatentable.....83

1. Petitioner failed to appropriately address element 19[e].....83

2. Petitioner still bears the burden on the merits, and its “supra element 1[f] and claim 10” cross-reference does not prove element 19[e].....83

3. *Menchik*’s cited disclosures do not satisfy element 19[e]’s “determining ... based upon at least one property ... in the data” requirement.....85

4. *Menchik*’s disclosures also do not establish that the “determined” parameter includes at least one of claim 19[e]’s enumerated requirements, including a “support structure requirement”85

E. Ground 3A Does Not Render Dependent Claims 3–5, 7, 9–11, and 20 Unpatentable.....88

1. Claim 3-588

2. Claim 10.....90

XI. Ground 3B: Claims 1, 3-5, 7, 9-11, and 20 Would Not Have Been Obvious Over Menchik (EX1009) and Jazayeri (EX1010)94

 A. Ground 3B Does Not Render Independent Claim 1 Unpatentable.....95

 B. Ground 3B Does Not Render Dependent Claims 3–5, 7, 9–11, 20 Unpatentable.....96

XII. Grounds 3C/3D: Claims 2, 8, 12, and 16 Would Not Have Been Obvious Over Ground 3C or Ground 3D96

XIII. Grounds 1E/1F/3E/3F: Claim 17 Would Not Have Been Obvious Over Grounds 1E/1F/3E/3F96

 A. Claim 1797

XIV. Grounds 1C/1D/3G/3H: Claim 5 Would Not Have Been Obvious Over Grounds 1C/1D/3G/3H102

 A. Overview of KISSlicer (EX1018).....103

 B. Claim 5103

 1. Petitioner’s Ground 1C/1D theory (Loughran + Dubois + KISSlicer, and Loughran + Dubois + Jazayeri + KISSlicer) does not teach “receiving a selection ... from the client” as claim 5 requires.....104

 2. Petitioner’s Ground 3G/3H theory (Menchik + KISSlicer, and Menchik + Jazayeri + KISSlicer) fails for the same reasons.....106

XV. Conclusion107

EXHIBIT LIST

Exhibit No.	Description
2001	Docket Navigator – Judge Rodney Gilstrap Motion Success for Stay Pending IPR and Time to Milestones
2002	United States District Courts — Judicial Caseload Profiles for Eastern District of Texas (Sept. 30, 2024 and Dec. 31, 2024), available at https://www.uscourts.gov/data-news/reports/statistical-reports/federal-court-management-statistics
2003	Minute Entry for proceedings held before District Judge Gilstrap on Nov. 7, 2024, <i>Stratasys, Inc. v. Shenzhen Tuozhu Technology Co. Ltd.</i> , No. 2:24-cv-00644-JRG (E.D. Tex. Nov. 14, 2024)
2004	Discovery Order, <i>Stratasys, Inc. v. Shenzhen Tuozhu Technology Co. Ltd.</i> , No. 2:24-cv-00644-JRG, Dkt No. 35 (E.D. Tex. Dec. 2, 2024)
2005	Protective Order, <i>Stratasys, Inc. v. Shenzhen Tuozhu Technology Co. Ltd.</i> , No. 2:24-cv-00644-JRG, Dkt No. 36 (E.D. Tex. Dec. 3, 2024)
2006	e-Discovery Order, <i>Stratasys, Inc. v. Shenzhen Tuozhu Technology Co. Ltd.</i> , No. 2:24-cv-00644-JRG, Dkt No. 41 (E.D. Tex. Dec. 19, 2024)
2007	Invalidity and Ineligibility Contentions, <i>Stratasys, Inc. v. Shenzhen Tuozhu Technology Co. Ltd.</i> , No. 2:24-cv-00644-JRG, (E.D. Tex. Jan. 30, 2025)
2008	Transcript of Hearing on the Nomination of Howard Lutnick, of New York, to be Secretary of Commerce (Jan. 29, 2025)
2009	Order Denying Defendants’ Motion to Dismiss for Failure to Join Indispensable Party, <i>Stratasys, Inc. v. Shenzhen Tuozhu Technology Co. Ltd.</i> , No. 2:24-cv-00644-JRG, Dkt. No. 53 (E.D. Tex. May 29, 2025)
2010	Plaintiff’s Unopposed Motion to Consolidate Case No. 2:25-cv-00465-JRG with Case Nos. 2:24-cv-00644-JRG and 2:24-cv-00645-JRG, <i>Stratasys, Inc. v. Shenzhen Tuozhu Technology Co. Ltd.</i> , No. 2:24-cv-00644-JRG, Dkt. No. 54 (E.D. Tex. May 30, 2025)
2011	Lex Machina, Patent Litigation Report 2024 (Feb. 2024)
2012	U.S. District Court, Eastern District of Texas [Live] Calendar Events Set for 6/1/2026-8/1/2026
2013	Declaration of Dr. Denis R. Cormier related to IPR2025-00438

2014	Upcraft, S. and Fletcher, R., 2003. The rapid prototyping technologies. <i>Assembly Automation</i> , 23(4), pp.318-330
2015	Transcript of January 9, 2026 Deposition of Dr. Hickner related to IPR2025-00438

I. INTRODUCTION

1. My name is Dr. Cormier, and I declare as follows.

2. I am over 18 years of age and have personal knowledge of the matters stated in this Declaration.

3. I have been asked to provide technical assistance in the inter partes review proceeding IPR2025-00438 concerning U.S. Patent No. 10,569,466 (the “466 Patent”). I understand that this patent is owned by Stratasy, Inc. (“Stratasy”). This Declaration sets forth my opinions related to the patentability of the challenged claims, including as discussed in Patent Owner’s Response.

A. Qualifications and Experience

4. I am the Earl W. Brinkman Endowed Professor of Advanced Machine Tools at the Rochester Institute of Technology (RIT), where I have been since 2009.

5. Prior to joining RIT, I was a faculty member at North Carolina State University for 15 years, from 1994 to 2009.

6. Over the past 30 years, my primary teaching, research, and service focus has been additive manufacturing and three-dimensional printing (3D printing). As part of this work, I have operated dozens of different 3D printers.

7. I earned a Bachelor of Science in Systems Engineering from the University of Pennsylvania in 1989, a Master of Science degree in Industrial

Engineering from State University of New York at Buffalo in 1991, and a Ph.D. in Industrial Engineering from North Carolina State University in 1995.

8. I am an inventor on 10 patents and have published well over 100 papers related to aspects of additive manufacturing and 3D printing.

9. Over the course of my career, I have been the principal investigator for over \$30 million in research grants and contracts related to additive manufacturing and 3D printing. My funding has come from dozens of companies, such as Boeing, General Electric, Xerox, Ford, and Intel, as well as from government agencies such as NASA, the Departments of Defense (Air Force, Navy, Army), and the National Science Foundation.

10. I have received numerous awards over the course of my career. I am the 2024 recipient of the International FAME award that recognizes career achievements in additive manufacturing and 3D printing research and development. I understand that only 17 individuals worldwide have received this prestigious award since its inception in 2009. In 2020, I was named by Smart Manufacturing Magazine on its 20 Most Influential Faculty in Smart Manufacturing list.

11. I frequently speak on topics related to additive manufacturing and 3D printing. I have given invited talks at conferences in France, Canada, Portugal, Germany, England, Ireland, China, Japan, and the U.S. Also, I serve on the Editorial

Advisory Board for two of the most prominent additive manufacturing / 3D printing research journals – *Additive Manufacturing*, and the *Rapid Prototyping Journal*.

12. I have also taught classes in additive manufacturing / 3D printing. Approximately 25 years ago, I was among the first faculty members worldwide to develop and teach a course dedicated to additive manufacturing / 3D printing. Since then, I have developed numerous additional additive manufacturing / 3D printing courses pertaining to topics such as 3D printing of metallic components, and 3D printed medical devices.

13. In addition to teaching additive manufacturing / 3D printing classes, I have taught computer-aided design (CAD) and computer-aided manufacturing (CAM) classes over the past 30 years. My teaching experience with machining processes, including computer numerically controlled (CNC) machining dates to the early 1990s.

14. My academic and professional background and qualifications are further elaborated in my curriculum vitae (Appendix A).

B. Compensation

15. I am being compensated at my normal rate of \$300 per hour for my analysis, plus reimbursement for expenses. My compensation does not depend on the content of my opinions or the outcome of this proceeding.

C. Scope of Work and Materials Considered

16. This declaration is based on my education, personal knowledge, and professional and academic experience in the area of three-dimensional printing.

17. I have been asked to review the Challenged Patent and its prosecution history, to provide an understanding of the technology relevant to the Challenged Patent, to review certain prior-art references, and to analyze whether or not those references disclose or teach limitations of claims from the Challenged Patent.

18. The opinions stated in this declaration are from the perspective of a Person of Skill in the Art (POSITA) as of October 29, 2012, whose qualifications and abilities are described below. I understand that Petitioner and Patent Owner may have a dispute as to whether the claims of the Challenged Patent are entitled to a priority date of at least October 29, 2012. Unless otherwise noted, my opinions expressed in this report remain unchanged regardless of the date used.

19. In forming my opinions, I have reviewed the Challenged Patent, its prosecution history, the materials cited in the List of Exhibits, and the materials cited throughout my declaration. I have also relied on my academic and professional experience in reaching the opinions expressed in this declaration.

II. THE CHALLENGED CLAIMS OF THE '466 PATENT

20. I understand that Petitioner has challenged claims 1-5, 7-13, and 16-20 of the '466 Patent (the "Challenged Claims"). The Challenged Claims are set forth below, with some claim elements further sub-divided for ease of reference:

Claim Element	Claim Language from '466 Patent
1[p]	A method, comprising:
1[a]	providing a three-dimensional printer that includes a tag sensor;
1[b]	receiving a request from a client over a network to fabricate an object on the three-dimensional printer,
1[c]	the three-dimensional printer coupled to a supply of a build material including a tag that stores at least one property of the build material;
1[d]	reading data from the tag with the tag sensor;
1[e]	providing the data from the tag to the client over the network, the data including at least one property of the build material;
1[f]	receiving one or more operational parameters from the client selected for use in controlling operation of the three-dimensional printer when fabricating the object with the build material having the at least one property stored in the tag; and
1[g]	fabricating the object with the build material according to the one or more operational parameters.
2	The method of claim 1, further comprising receiving a request from the client for the data from the tag.
3	The method of claim 1, wherein the three-dimensional printer is coupled to a first supply of a first build material and a second supply of a second build material different from the first build material, the first supply including a first tag that stores at least one property of the first build material, and the second supply including a second tag that stores at least one property of the second build material.

Claim Element	Claim Language from '466 Patent
4	The method of claim 3, further comprising providing data from the first tag and the second tag to the client over the network, the data including at least one property of the first build material and the second build material.
5	The method of claim 4, further comprising receiving a selection of one of the first build material and the second build material from the client for use in fabricating the object using the three-dimensional printer.
7	The method of claim 1, further comprising fabricating the object with the three-dimensional printer based upon the one or more operational parameters received from the client.
8	The method of claim 1, wherein the tag includes at least one of a radio frequency identification (RFID) tag, an optically-identifiable tag, a magnetically-identifiable tag, and a mechanical feature of the supply.
9	The method of claim 1, wherein the data includes at least one of a material identification number, a build material type, a build material diameter, an extruder temperature requirement, a build material melting temperature, a build material color, a build material color lot number, a cost per unit of build material, a build material density, a build material tensile strength, a build material viscosity, a build material recycle code, and a build material expiration date.
10	The method of claim 1, wherein the one or more operational parameters includes at least one of an extruder temperature, a feed rate, a build platform temperature, a build volume temperature, an infill requirement, a rafting requirement, a support structure requirement, and a cooling requirement.
11	The method of claim 1, wherein the supply includes at least one of a cartridge, a spool, a filament, a number of pellets, and a liquid.
12	The method of claim 1, wherein the tag includes a radio frequency identification (RFID) tag, and the RFID tag is at least one of a passive RFID tag and an active RFID tag.
13	The method of claim 1, wherein the tag includes an

Claim Element	Claim Language from '466 Patent
	optically-identifiable tag, and the optically-identifiable tag is at least one of bar code and quick read (QR) code.
16	The method of claim 1, wherein the tag sensor includes at least one of a radio frequency identification (RFID) reader, an optical scanner, a magnetic reader, and a contact point sensor.
17	The method of claim 1, further comprising performing a diagnostic test to determine whether the one or more operational parameters is suitable for the three-dimensional printer.
18	The method of claim 1, wherein the one or more operational parameters are based upon a build material identification number contained in the data.
19[p]	A method, comprising:
19[a]	providing a three-dimensional printer that includes a controller and a tag sensor;
19[b]	coupling a container of a build material to the three-dimensional printer, the container including a tag that stores at least one property of the build material;
19[c]	reading data from the tag with the tag sensor;
19[d]	transmitting the data to the controller;
19[e]	determining an operational parameter for configuring the three-dimensional printer for a fabrication process using the build material based upon at least one property of the build material in the data, the operational parameter including at least one of a build platform temperature, a build volume temperature, an infill requirement, a rafting requirement, a support structure requirement, and a cooling requirement;
19[f]	controlling operation of the three-dimensional printer with the controller according to the operational parameter; and fabricating an object with the three-dimensional printer based upon the operational parameter.
20	The method of claim 1, wherein the client includes a computing device.

III. LEVEL OF ORDINARY SKILL IN THE ART

21. When interpreting a patent, I understand that it is important to identify the relevant art pertaining to the Challenged Patent as well as the level of ordinary skill in that art at the time of the claimed invention. The “art” is the field of technology to which the patent is related.

22. I have been instructed by counsel that the person of ordinary skill in the art (“**POSITA**”) is a hypothetical person who is presumed to know the relevant prior art. I understand that the actual inventor’s skill is not determinative of the level of ordinary skill. I further understand that a person of ordinary skill in the art is determined by looking at (1) the type of problems encountered in the art; (2) the prior-art solutions to those problems; (3) the rapidity with which innovations are made; (4) the sophistication of the technology; and (5) the educational level of active workers in the field.

23. In my opinion, a person of ordinary skill in the art with respect to the ’466 Patent is someone with a bachelor’s degree in Mechanical Engineering, Computer Engineering, Electrical Engineering, Chemical Engineering, Materials Science, or a comparable field and at least two years of experience related to 3D printing, with additional experience potentially being a substitute for a formal degree or training (and vice versa).

24. I understand that Petitioner and Petitioner's expert, Dr. Hickner, have proposed a somewhat different level of ordinary skill in the art. Specifically, they assert that a person of ordinary skill in the art "would have had (1) at least a bachelor's degree in Mechanical Engineering, Computer Engineering, Chemical Engineering, Materials Science, or a related field, and (2) at least two years of research or industry experience in 3D printing or materials used for 3D printing. Additional experience could substitute for a formal degree or formal training (and vice versa)." EX1003 (Declaration of Dr. Hickner), at ¶20; Petition, at 6. My opinions in this declaration would not change under this proposed level of ordinary skill in the art.

25. As I mentioned, I have degrees in Systems Engineering and Industrial Engineering, which are in a comparable field to Mechanical Engineering, Chemical Engineering, and Materials Science. Among other things, I had been developing courses for additive manufacturing and 3D printing for many years prior to 2012, and I was listed as an inventor on patents related to 3D printing well before 2012.

26. In rendering my opinions in this declaration, I have viewed the '466 Patent from the perspective of a POSITA under either my definition or Dr. Hickner's definition. As I discussed above, my education, experience and knowledge, and technical expertise show that I meet the qualifications of a POSITA under either my definition or Dr. Hickner's definition.

IV. LEGAL STANDARDS

27. I am not a legal expert. In presenting my opinions, I have applied the legal standards provided to me by counsel in arriving at the opinions set forth in this declaration.

28. I understand that in this *inter partes* review proceeding, the Petitioner has the burden of proving that the claims of a Challenged Patent are unpatentable in light of the prior art by a preponderance of the evidence. I understand that a preponderance of the evidence is evidence sufficient to show that a fact is more likely true than not true.

A. Legal Standard for Claim Construction

29. I understand that the first step in determining whether a patent claim would have been anticipated or obvious is to ascertain how a POSITA would have understood the claim terms.

30. I have been instructed by counsel on the law regarding claim construction and patent claims. I understand that a patent may include two types of claims: independent claims and dependent claims. An independent claim stands alone and includes only the limitations it recites. A dependent claim can depend from an independent claim, or it can further depend from another dependent claim. I understand that a dependent claim includes all the limitations that it recites, as well as all the limitations recited in the claim(s) from which it depends.

31. It is my understanding that in proceedings before the PTAB, the claims of a patent are to be construed under what is referred to as the “*Phillips* standard.” I understand that this means that claim terms of a patent are given the meaning the terms would have to a POSITA, in view of the description provided in the patent itself and the patent’s file history.

32. I understand that to determine how a person of ordinary skill would understand a claim term, one should look to those sources available that show what a person of skill in the art would have understood the disputed claim language to mean. These sources include the words of the claims themselves, the rest of the patent’s description, the prosecution history of the patent (all of which considered “intrinsic” evidence), and “extrinsic” evidence concerning relevant scientific principles, the meaning of technical terms, the technical literature on established and emerging relevant technologies, and the state of the art at the time of the invention.

33. I understand that, in construing a claim term, one looks primarily to the intrinsic evidence, including the words of the claims themselves, the remainder of the patent, and the patent’s prosecution history.

34. I understand that extrinsic evidence, which is evidence external to the patent and the prosecution history, may also be useful in interpreting patent claims when the intrinsic evidence itself is insufficient.

35. I understand that words or terms should be given their ordinary and accepted meaning unless it appears that the inventors were using them to mean something else. In making this determination, the claims, the remainder of the patent, and the prosecution history are of principal importance. Additionally, the patent and its prosecution history must be consulted to confirm whether the patentee has acted as its own lexicographer (i.e., provided its own special meaning to any disputed terms), or intentionally disclaimed, disavowed, or surrendered any claim scope.

36. I understand that the claims of a patent define the scope of the rights conferred by the patent. The claims particularly point out and distinctly claim the subject matter which the patentee regards as his invention. Because the patentee is required to define precisely what he claims his invention to be, it is not proper to construe claims in a manner different from the plain import of the terms as used in the patent. Accordingly, a claim construction analysis must begin and remain centered on the claim language itself. Additionally, the context in which a term is used in the asserted claim can be highly instructive. Likewise, other claims of the patent in question, both challenged and un-challenged, can inform the meaning of a claim term. For example, because claim terms are normally used consistently throughout the patent, the usage of a term in one claim can often illuminate the meaning of the same term in other claims. Differences among claims can also be a useful guide in understanding the meaning of particular claim terms.

37. I understand that a person of ordinary skill in the art is deemed to read a claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the remaining text and figures. For this reason, the words of the claim must be interpreted in view of the entirety of the patent specification (i.e., the claims, remaining text, and figures). The written description (figures and remaining text) is the primary basis for construing the claims and provides a safeguard such that correct constructions closely align with the patent.

38. In addition to consulting the patent itself, I understand that one should also consider the patent's prosecution history. The prosecution history provides evidence of how both the Patent Office and the inventors understood the terms of the patent, particularly in light of what was known in the prior art.

39. I understand that while intrinsic evidence is of primary importance, extrinsic evidence, e.g., all evidence external to the patent and prosecution history, including expert and inventor testimony, dictionaries, and learned treatises, can also be considered. Extrinsic evidence should not be considered, however, divorced from the context of the intrinsic evidence. Furthermore, while extrinsic evidence can shed useful light on the relevant art, it is less significant than the intrinsic record in determining the legally operative meaning of claim language.

B. Legal Standard for Prior Art

40. I understand that a patent or other publication must first qualify as prior art before it can be used to invalidate a patent claim.

41. I understand that to qualify as prior art, a reference must contain an enabling disclosure that allows one of ordinary skill to practice the claims of the Challenged Patent without undue experimentation. I understand that a patent issued by the United States Patent and Trademark Office is presumed to provide an enabling disclosure. Factors to consider in determining whether undue experimentation is needed are: (1) the quantity of experimentation necessary, (2) the amount of direction or guidance presented, (3) the presence or absence of working examples, (4) the nature of the invention, (5) the state of the prior art, (6) the relative skill of those in the art, (7) the predictability or unpredictability of the art, and (8) the breadth of the claims.

42. I understand that for a prior-art reference to be considered for obviousness, the reference must be “analogous.” I understand that the comparison for purposes of determining “analogous” is between the asserted prior-art reference and the Challenged Patent. I have been further informed that for a prior-art reference to be considered “analogous” to the Challenged Patent and thus available as prior art for obviousness, if (1) the reference is from the same field of endeavor as the Challenged Patent, even if it addresses a different problem; or (2) the reference is

reasonably pertinent to the particular problem the Challenged Patent is concerned with, even if it is not within the same field of endeavor.

C. Legal Standard for Patentability

43. I understand that for an invention claimed in a patent to be found patentable, it must be (among other things) new and not obvious based on what was known before the invention was made.

44. I understand that, once the claims of a patent have been properly construed, the second step in determining patentability of a patent claim requires a comparison of the properly construed claim language to the prior art on a limitation-by-limitation basis.

45. I understand that for purposes of this declaration, there are two ways to demonstrate that a patent claim is not patentable. A patent claim can be anticipated, or a patent claim can be obvious. I address each of these below.

1. Anticipation and Inherency

46. I understand that prior art can “anticipate” the claims of an asserted patent. It is my understanding that in order for a claim to be anticipated by the prior art, every element of that claim must be found, explicitly or inherently, in a single prior art reference. In other words, to determine whether a single prior art reference anticipates a patent claim, one should consider not only what is expressly disclosed

in that reference, but also what inherently occurred as a natural result of the practice of the system or method disclosed in that prior art reference.

47. It is further my understanding that to establish such inherency, the missing descriptive matter must be necessarily present in the item of prior art and that it would be so recognized by persons of ordinary skill in the art. It is also my understanding that such inherency may be shown through extrinsic evidence.

2. Obviousness

48. I understand that the prior art may render a patent claim “obvious.” I understand that two or more prior art references (e.g., prior art articles, patents, or publications) that each disclose fewer than all elements of a patent claim may nevertheless be combined to render a patent claim obvious if the combination of the prior art collectively discloses all elements of the claim and one of ordinary skill in the art at the time would have been motivated to combine the prior art in such a way with a reasonable expectation of success.

49. I understand that this motivation to combine need not be explicit in any of the prior art, but it may be inferred from the knowledge of one of ordinary skill in the art at the time the patent was filed. I also understand that one of ordinary skill in the art is not an automaton but is a person having ordinary creativity. I further understand that an obviousness analysis recognizes that market demand often drives innovation, and that a motivation to combine references may be supplied by the

direction of the marketplace. I further understand that one or more prior art references, articles, patents or publications that disclose fewer than all of the elements of a patent claim may render a patent claim obvious if including the missing element would have been obvious to one of skill in the art (e.g., the missing element represents only an insubstantial difference over the prior art or a reconfiguration of a known system).

50. I understand that a person of ordinary skill in the art provides a reference point from which the prior art and claimed invention should be viewed. This reference point prevents a person of ordinary skill from using hindsight in deciding whether a claim is obvious.

51. I also understand that an obviousness determination includes the consideration of various factors such as (1) the scope and content of the prior art, (2) the differences between the prior art and the challenged claims, (3) the level of ordinary skill in the pertinent art, and (4) when in evidence, the existence of secondary considerations (such as commercial success, long-felt but unresolved needs, failure of others, etc.) to the extent they exist and have a nexus to the claimed invention.

52. I am informed that secondary indicia of non-obviousness (also known as secondary considerations) may include (1) a long felt but unmet need in the prior art that was satisfied by the invention of the patent; (2) commercial success or lack

of commercial success of processes covered by the patent; (3) unexpected results achieved by the invention; (4) praise of the invention by others skilled in the art; (5) taking of licenses under the patent by others; and (6) deliberate copying of the invention. I also understand that there must be a relationship between any such secondary indicia and the invention. I further understand that contemporaneous and independent invention by others is a secondary consideration supporting an obviousness determination. I also understand that secondary considerations are given less weight when the alleged invention represents a relatively small advance in a crowded field with predictable results. I further understand that the patentee has the burden of coming forward with evidence of the relationship between any secondary consideration of non-obviousness and the claimed invention (also known as the “nexus”).

53. It is also my understanding that there are additional considerations that may be used as further guidance as to when the above factors will result in a finding that a claim is obvious, including the following:

- the claimed subject matter is simply a combination of prior art elements according to known methods to yield predictable results;
- the claimed subject matter is a simple substitution of one known element for another to obtain predictable results;
- the claimed subject matter uses known techniques to improve similar devices or methods in the same way;
- the claimed subject matter applies a known technique to a known device or method that is ready for improvement to yield predictable results;

- there is known work in one field of endeavor that may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to a POSITA;
- there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims; and
- there is some teaching, suggestion, or motivation in the prior art that would have led a POSITA to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed subject matter.

54. I understand that a particular combination may be proven obvious by showing that it was obvious to try the combination. For example, when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp because the result is likely the product not of innovation but of ordinary skill and common sense.

55. I further understand that a claim may be deemed invalid for obviousness in light of a single prior art reference, without the need to combine references, if the elements of the claim that are not found in the reference can be supplied by the knowledge or common sense of one of ordinary skill in the relevant art.

56. I also understand that practical and common-sense considerations should guide a proper obviousness analysis, because familiar items may have obvious uses beyond their primary purposes. I further understand that a person of ordinary skill in the art looking to overcome a problem will often be able to fit the teachings of multiple publications together like pieces of a puzzle, although the prior

art need not be like two puzzle pieces that must fit perfectly together. I understand that an obviousness analysis therefore considers the inferences and creative steps that a person of ordinary skill in the art would employ under the circumstances.

57. I understand that a person of ordinary skill could have combined two pieces of prior art or substituted one prior art element for another if the substitution can be made with predictable results, even if the swapped-in element is different from the swapped-out element. I understand that the relevant question is whether prior art techniques are interoperable with respect to one another, such that a person of skill would view them as a design choice, or whether a person of skill could apply prior art techniques into a new combined system.

58. In sum, my understanding is that prior art teachings are properly combined where a person of ordinary skill in the art having the understanding and knowledge reflected in the prior art and motivated by the general problem facing the inventor, would have been led to make the combination of elements recited in the claims. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor at the time of the invention, can provide a reason for combining the elements of multiple prior art references in the claimed manner.

V. THE '466 PATENT AND THE CHALLENGED CLAIMS

A. Summary of the '466 Patent (EX1001)

59. I have reviewed the '466 Patent, which relates to “three-dimensional printers” that “use build material of various type and configuration to print three-dimensional objects.” EX1001 at 1:16-18. As the patent explains, “at least a basic set of characteristics of the build material to determine operation” may be needed “[i]n order to properly process the build material through the three-dimensional printer extruder for the fabrication of an object.” *Id.* at 1:18-22. Thus, there is “a need for methods and systems for the automatic detection and acquiring of three-dimensional printer build material characteristics.” *Id.* at 1:23-25.

60. Based on my review of the '466 Patent, Figure 3 of the '466 Patent shows a three-dimensional printer system 300 that includes a three-dimensional printer 306 with a tag sensor 310 to read a data tag 304 included on a supply 302 of build material 312.

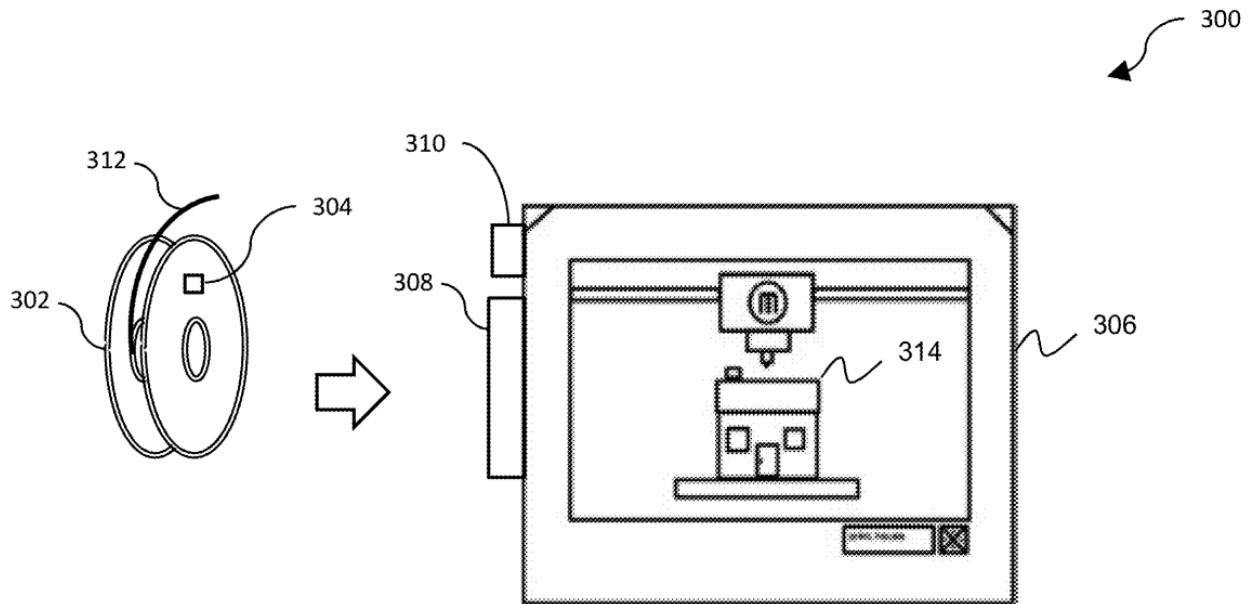


Fig. 3

Id. at 13:65-67, 14:30-35, 14:56-59, Fig. 3. As shown, the supply of material can be coupled via 308 to the three-dimensional printer 306 for the fabrication of an object 314. *Id.* at 14:9-23, 15:11-17, Fig. 3; *see also id.* at Figs. 4A-4C.

61. A diagram of a three-dimensional printer 100 is shown below in Figure 1 with a build platform 102, extruder 106, and controller 110 that cooperate “to fabricate an object 112 within a working volume 114” *Id.* at 2:25-29, Fig. 1.

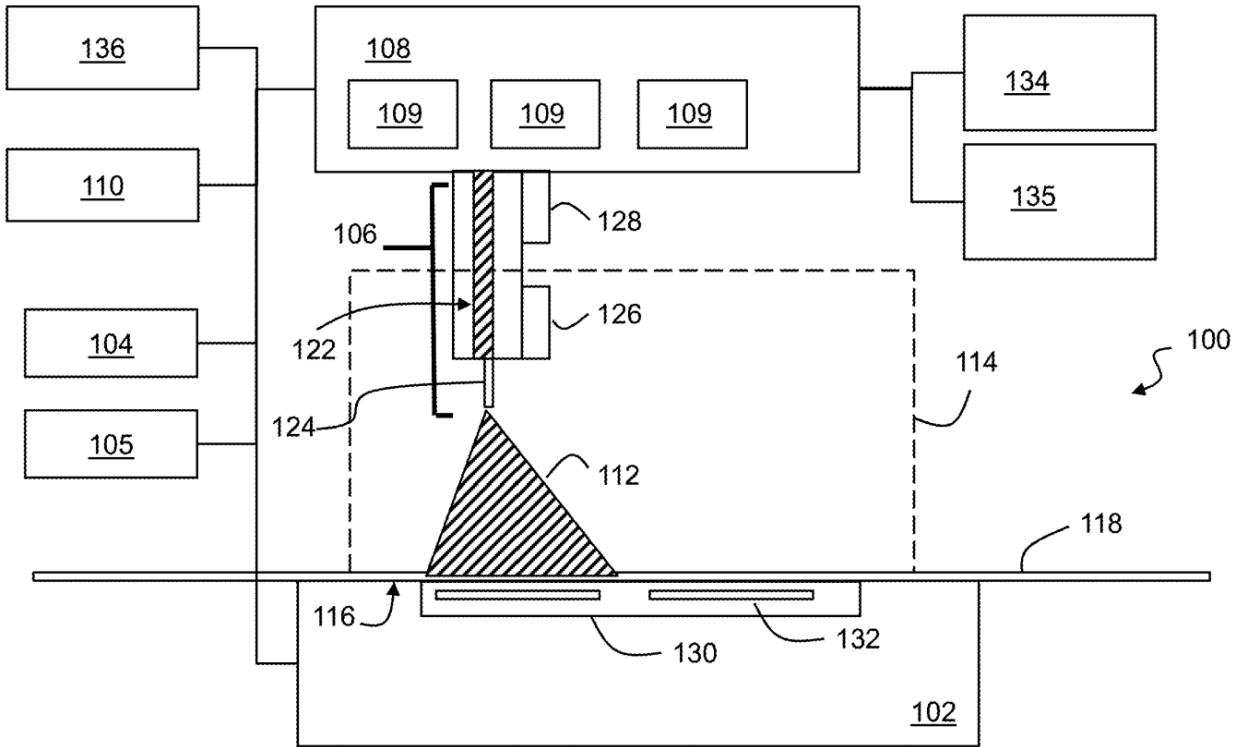


Fig. 1

Id. at Fig. 1.

62. To read build material tag data and fabricate an object, the '466 Patent illustrates a flowchart in Figure 6. *Id.* at 1:50-52.

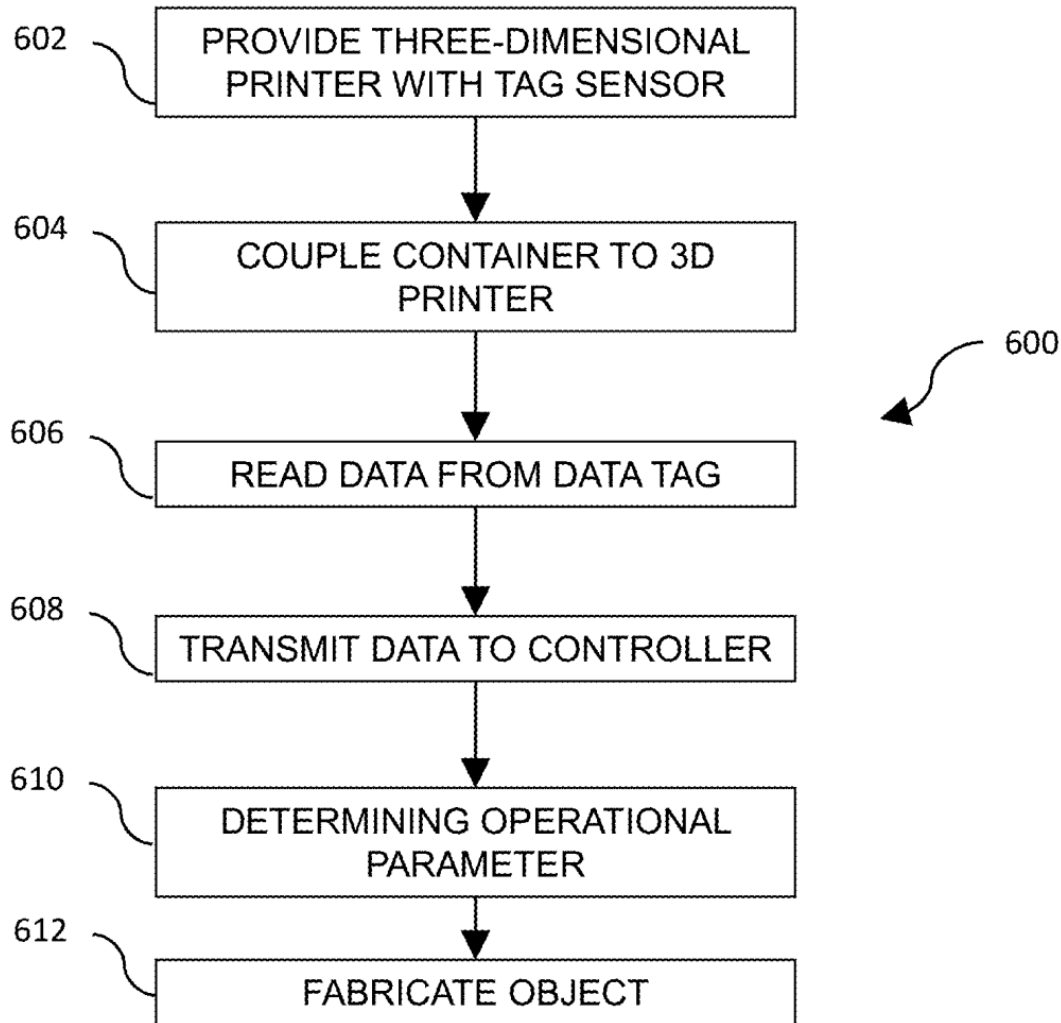


Fig. 6

Id. at Fig. 6. At step 602, a three-dimensional printer is provided with a tag sensor, such as via an add-on component to the printer. *See id.* at 20:64-21:4. At step 604, a container for build material with a data tag is coupled to the three-dimensional printer. *Id.* at 21:5-13. The data on the tag may include information about the

mechanical, structural, thermal, and aesthetic properties of the build material. *Id.* at 21:14-20.

63. At step 606, the data on the data tag is read using the tag sensor. *Id.* at 21:39-41. And then, at step 608, the data read from the tag sensor may be transmitted to a controller. *Id.* at 21:44-45.

64. At step 610, an operational parameter for fabrication of the object may be determined based on data from the data tag. Namely, information about the build material that is stored in the data tag can be used to determine how the build material should be used in a fabrication process. *See id.* at 21:50-56. For instance, a controller associated with the three-dimensional printer may use the type of build material to determine “an extruder temperature, a feed rate, a build platform temperature, a build volume temperature, an infill requirement, a rafting requirement, a support structure requirement, an extruder movement speed, and a cooling requirement.” *See id.* at 21:56-61. The determined operational parameter may be transmitted from a remote resource to the three-dimensional printer to fabricate an object. *See id.* at 16:34-40, 16:41-55.

65. At step 612, the object is fabricated while using the operational parameter to control operation of the three-dimensional printer. *See id.* at 22:21-24. As a result, “a user may simply load a build material from a suitably instrumented

container and select an object to print without specifying various configuration details that might otherwise be required.” *Id.* at 22:27-31.

66. Based on my revise of the '466 Patent, numerous claims embody these solutions, including independent claims 1 and 19 and their dependent claims. For instance, claim 1 recites “reading data from the tag with the tag sensor;” “providing the data from the tag to the client over the network, the data including at least one property of the build material;” “receiving one or more operational parameters from the client selected for use in controlling operation of the three-dimensional printer when fabricating the object with the build material having the at least one property stored in the tag; and” “fabricating the object with the build material according to the one or more operational parameters.” *Id.* at 23:40-50. Similarly, claim 19 recites “reading data from the tag with the tag sensor;” “transmitting the data to the controller;” “determining an operational parameter for configuring the three-dimensional printer for a fabrication process using the build material based upon at least one property of the build material in the data, the operational parameter including at least one of a build platform temperature, a build volume temperature, an infill requirement, a rafting requirement, a support structure requirement, and a cooling requirement;” “controlling operation of the three-dimensional printer with the controller according to the operational parameter; and” “fabricating an object

with the three-dimensional printer based upon the operational parameter.” *Id.* at 24:60-25:7.

67. As I explain below, the asserted grounds fail to teach the elements of claims 1 and 19. Because claims 2-5, 7-13, 16-18 depend from claim 1 and claim 20 depends from claim 19, the asserted grounds also fail to teach the elements of dependent claims 2-5, 7-13, 16-18, and 20 for at least the same reasons. In addition, the asserted grounds fail to teach additional limitations of dependent claims, including 3-5, 10, and 17.

B. Summary of Prosecution History of the '466 Patent (EX1002)

68. I have reviewed the prosecution history of the '466 Patent (EX1002). During prosecution, the applicant explained that unlike the cited art, the operational parameter(s), which are based on information that is read from a tagged container, must be used when fabricating an object. EX1002 at 160. The applicant explained that the examiner correctly noted that U.S. Patent No. 8,286,236 to Jung, et al. (“*Jung*”) did not disclose a tag sensor associated with a controller and a tag that stores one or more properties of the build material on a container that stores the material. EX1002 at 159; *see also id.* at 120-21. The examiner had rejected the claims over *Jung* in view of U.S. Patent No. 7,520,740 to Wahlstrom, et al. (“*Wahlstrom*”). EX1002 at 158, 120. But the applicant argued that *Wahlstrom* only described tags and readers for identifying expired or unauthorized material to sound

an alarm. *See* EX1002 at 159-60. Thus, there was no teaching or suggestion of adjusting operational parameters used when fabricating an object based on information that was read from a tagged container. *See id.* In response to applicant's arguments, the examiner allowed the claims explaining that the prior art fails to teach or suggest the claimed method. *See* EX1002 at 176, 202.

69. As I explain below, the references asserted in the Petition suffer from similar deficiencies as the art cited during prosecution.

VI. SUMMARY OF PETITIONER'S GROUNDS

70. I understand that Petitioner has advanced Grounds 1A-1F, 2, 3A-3H. Pet. at 1-2. The table below from the Petition summarizes the Petitioner's Grounds:

Ground	Claims	Basis for Rejection
1A	1-5, 7-13, 16, 18, 20	§103: Loughran and Dubois
1B	1-5, 7-13, 16, 18, 20	§103: Loughran, Dubois, and Jazayeri
1C	5	§103: Loughran, Dubois, and KISSlicer
1D	5	§103: Loughran, Dubois, Jazayer, and KISSlicer
1E	17	§103: Loughran, Dubois, Menchik, and Dahlin
1F	17	§103: Loughran, Dubois, Jazayer, Menchik, and Dahlin
2	19	§103: Devos
3A	1, 3-5, 7, 9-11, 19, 20	§102/103: Menchik
3B	1, 3-5, 7, 9-11, 20	§103: Menchik and Jazayeri

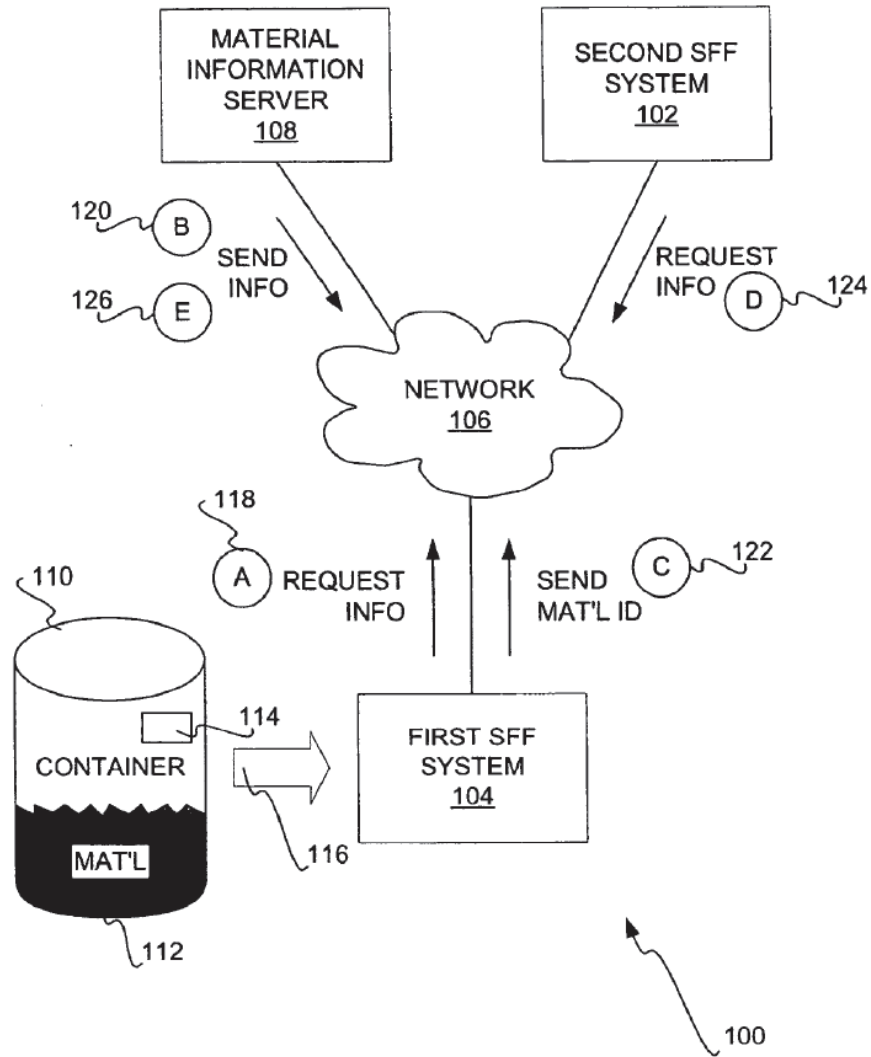
3C	2, 8, 12, 16	§103: Menchik and Loughran
3D	2, 8, 12, 16	§103: Menchik, Jazayeri, and Loughran
3E	17	§103: Menchik and Dahlin
3F	17	§103: Menchik, Jazayeri, and Dahlin
3G	5	§103: Menchik and KISSlicer
3H	5	§103: Menchik, Jazayeri, and KISSlicer

VII. GROUND 1A: CLAIMS 1-5, 7-13, 16, 18, AND 20 WOULD NOT HAVE BEEN OBVIOUS OVER LOUGHRAN (EX1004) AND DUBOIS (EX1005)

71. I understand that in Ground 1A of the Petition, Petitioner asserts that claims 1-5, 7-13, 16, 18, and 20 are obvious over Loughran (EX1004) and Dubois (EX1005). I have reviewed Petitioner's challenges in Ground 1A, and it is my opinion that Ground 1A fails to teach or suggest all elements of claims 1-5, 7-13, 16, 18, and 20. I explain my opinions below in detail.

A. Overview of *Loughran* (EX1004)

72. I have reviewed Loughran (EX1004), which discloses retrieving information on material used in solid freeform fabrication (SFF). *See* EX1004 at Title. As shown below in Figure 1, Loughran's system 100 includes two SFF systems (102, 104) and a material information server (108).



EX1004 at Fig. 1, ¶ [0012]. Material container 110 is shown with a tag 114 that includes a material identifier. See EX1004, ¶¶ [0020], [0021]. Based on the material

identifier, the SFF system (104)¹ is able to recognize material 112 introduced to the system and determine whether the material is known or unknown. *See* EX1004, ¶[0020]. When Loughran's teachings are used in an inkjet SFF system, the material is held in a melted liquid state in reservoirs and fed to individual jetting heads that squirt tiny droplets of the materials in the required pattern. EX1004, ¶[0016]. After a layer of the object is formed, Loughran explains that a milling head is passed over the layer to cut the layer in a destructive manner to achieve uniformity. *See* EX1004, ¶[0016].

73. If the material is unknown, SFF system 104 requests information about the material from material information server (108) as indicated by the letter 'A.' *See* EX1004, ¶[0022], Fig. 1.

74. In response to the request, material information server 108 sends information about the material to SFF system 104, as indicated by the letter 'B.' *See* EX1004, ¶[0023], Fig. 1. SFF system 104 then knows the material and stores the material identifier in association with the information received from material

¹ The description of *Loughran* refers to SFF system 104 as the second SFF system whereas Figure 1 of *Loughran* refers to system 104 as the first SFF system. *Compare* EX1004 at ¶[0020] *with* EX1004 at Fig. 1. I refer to SFF system 104 and SFF system 102 consistent with Figure 1 and the written description of *Loughran*.

information server 108. EX1004, ¶[0023], Fig. 1. As a result, SFF system 104 can “automatically and dynamically” adjust its use of the material to fabricate physical objects. *See* EX1004, ¶[0024], [0025]. These adjustments can occur while SFF system 104 is running, without having to reboot the system and can also occur without user intervention and involvement. *See* EX1004, ¶[0037].

75. Another SFF system (102) in Loughran provides SFF jobs to SFF system 104, which fabricates the objects for the jobs as discussed above. EX1004, ¶[0012]. SFF system 102 can also request information about the material. SFF system 104 can send a material identifier to SFF system 102 as indicated by the letter ‘C.’ EX1004, ¶[0028], Fig. 1. SFF system 102 may request information about the material from material information server 108 as indicated by the letter ‘D.’ *See* EX1004, ¶[0028], Fig. 1. The material information server 108 sends the information to SFF system 102 as indicated by the letter ‘E.’ *See* EX1004, ¶[0028], Fig. 1. Loughran explains that SFF system 102 can use material information, for example, to estimate build time, suggest feature orientation, or determine part scaling based on expected shrinkage. *See* EX1004, ¶[0027].

B. Overview of *Dubois* (EX1005)

76. I have reviewed *Dubois* (EX1005), which discloses the production of a three-dimensional multi-material object via ink-jet printing. EX1005, Title, ¶[0001]. *Dubois* explains that he uses ink-jet printing in a non-subtractive method

that successively adds materials without employing a moulding stage and without using tools to remove material. *See* EX1005, ¶[0002]. A printer according to Dubois’s teachings uses its own data processing unit, which can accept user input to determine the print layers to be printed successively. EX1005, ¶¶[0048]–[0049], [0149]–[0150], Figs. 5–6.

C. No Motivation to Combine *Loughran* and *Dubois*

77. I understand that Petitioner contends a POSITA would have modified Loughran’s networked SFF system to “employ[] Dubois’s suggestion” of “sending the fabrication job from the CAD client using CAD information that includes printing parameters concerning the state or characteristics of the materials,” allegedly enabling fabrication “with the optimal set of material parameters.” (Pet. at 10; EX1003 ¶45). Petitioner further asserts a POSITA would have combined the references so that Loughran’s printer uses, “for each individual fabrication job,” Dubois’s “optimum values of printing parameters as a function of the nature of the materials, the characteristics of the printer and deposition conditions.” (Pet. at 11; EX1005 ¶[0148]; EX1003 ¶46). Petitioner additionally relies on Dubois’s statement that “it is important to control the nature of the materials in the printer ... and to use the various functions of the printer optimally,” and argues this purportedly motivates the combination so that “various functions” of Loughran’s printer “are optimally utilized for each individual fabrication job.” (Pet. at 12;

EX1005 ¶[0011]; EX1003 ¶47). Finally, Petitioner contends that combining Loughran and Dubois “would have been merely the application of known techniques to a known system ready for improvement to yield predictable results.” (Pet. at 12; EX1003 ¶48).

78. I understand that at institution, the Board credited Petitioner’s rationale on the preliminary record and concluded that combining Loughran and Dubois was “no more than a ‘combination of familiar elements according to known methods ... [which] does no more than yield predictable results.’” (Inst. Dec. at 17). However, the full record shows Petitioner’s asserted “send printing parameters in the job” rationale conflicts with Loughran’s disclosed architecture, which relies on printer-side automatic and dynamic adjustment based on information retrieved from a material-information server. (EX1004 ¶¶[0024]–[0026], [0037]). Loughran explains that the material-information server can provide information (including in machine-readable form) “by which the second SFF system ... is automatically and dynamically adjusted,” including process parameters tied to fabrication with the particular material. (EX1004 ¶[0024]). Loughran further teaches that the printer-side system “parses the retrieved information regarding the material ... [to] extract parameters” and then “dynamically adjusts its own parameters” for fabrication with that material. (EX1004 ¶[0037]).

79. In my opinion, Petitioner’s motivation theory, by contrast, depends on redesigning Loughran so the CAD client sends the printer a fabrication job “including CAD information with operational parameters as suggested by Dubois,” i.e., shifting parameter-setting into the client-generated job. (Pet. at 10–12; EX1003 ¶¶45–47). That proposed shift is not a “reason to combine” grounded in a technical need identified in Loughran, because Loughran already discloses the printer obtaining the relevant material-linked parameters from the server and dynamically adjusting itself accordingly. (EX1004 ¶¶[0024]–[0026], [0037]).

80. In my opinion, nor does Dubois supply the missing motivation for Petitioner’s particular modification, because Dubois’s “optimum values” framework is implemented through a printer-side “computation unit” and “data processing unit” that determine print layers, trajectories, and printing parameters as a function of input data and information (including the state of materials, printer characteristics, and deposition conditions). (EX1005 ¶¶[0148]–[0156]). Dubois emphasizes that quality depends on parameters “representative of the nature of the [materials] used, the properties of the printer and the computer-aided design,” and cautions about “problems associated with computer-aided design,” including that “computer-aided design . . . does not allow optimum definition” of the patterns to be printed. (EX1005 ¶¶[0016]–[0017]).

81. In my opinion, Petitioner never explains how Loughran’s remote CAD client would possess (or be provided) the printer-characteristics and deposition-condition inputs that Dubois identifies as necessary to determine “optimum values,” particularly where Loughran’s disclosed solution is to place the material-linked parameter retrieval and dynamic adjustment on the printer side via the material-information server workflow. (Pet. at 11; EX1005 ¶¶[0148]; EX1004 ¶¶[0024], [0037]).

1. Petitioner’s “predictable results” theory does not supply the required motivation to combine

82. I understand that Petitioner argues that importing Dubois’s parameter-determination concepts into Loughran would be the application of known techniques yielding predictable results. (Pet. at 12; EX1003 ¶48). However, Petitioner does not provide a reasoned explanation grounded in the prior art as to why a POSITA would have made the particular modification proposed, and Petitioner’s analysis is conclusory where it does not identify any specific deficiency in Loughran that Dubois’s approach purportedly addresses. (Pet. at 10–12; EX1004 ¶¶[0024]–[0026], [0037]; EX1005 ¶¶[0148]–[0156]).

a) This is not a simple “combination of familiar elements according to known methods.”

83. In my opinion, Petitioner’s theory requires shifting parameter-setting into the client-generated job, even though Loughran teaches that the printer is

“automatically and dynamically adjusted” based on server-provided material information parsed on the printer side. (Pet. at 10–12; EX1004 ¶¶[0024]; EX1004 ¶¶[0037]). That architecture-level reallocation of where parameters are determined and applied is not shown to be a “known method” in the asserted art, and Petitioner never explains how the redesign preserves Loughran’s disclosed operating principle of printer-side dynamic adjustment. (Pet. at 10–12; EX1004 ¶¶[0024]–[0026], [0037]). I note that Dr. Hickner during his deposition testified that he did not propose any specific data flow or architecture for the asserted combination—no schematic, no information path—relying instead only on generalized POSITA “routine” modification, which he could not explain. (EX2015, 68:10–79:15).

b) “Obvious to try” is not established.

84. In my opinion, Petitioner does not identify a finite set of identified options for improving Loughran’s system that would have predictably led a POSITA to adopt Dubois’s printer-side “optimum values” framework while also moving parameter-selection into the CAD client job as Petitioner proposes. (Pet. at 10–12; EX1003 ¶¶45–48; EX1005 ¶¶[0148]–[0156]; EX1004 ¶¶[0024]–[0026], [0037]).

c) Dubois’s “known technique” is not directed to Petitioner’s proposed client-side parameter selection.

85. Based on my review, Dubois teaches a printer-centric framework in which a data processing unit/database selects optimum parameters as a function of

materials, printer characteristics, and deposition conditions, which is inconsistent with Petitioner’s asserted modification that the CAD client sends the parameters in the fabrication job. (EX1005 ¶¶[0148]–[0156]; Pet. at 10–12; EX1003 ¶¶45–47). Petitioner’s discussion therefore does not supply the missing explanation for why a POSITA would re-architect Loughran to move parameter-setting to the CAD client when Dubois itself emphasizes printer-side computation dependent on printer/deposition-condition inputs. (EX1005 ¶¶[0016]–[0017], [0148]–[0156]). In fact, Dr. Hickner conceded that Dubois “doesn’t really talk about clients and networks,” and he further admitted Dubois “doesn’t address tags”—the very mechanisms that drive the tag to client workflow in the ’466 Patent. (EX2015, 61:13–22; 105:13–22).

d) Hindsight concerns underscore the lack of a non-conclusory rationale.

86. In my opinion, Petitioner provides a high-level justification for filling perceived gaps by hindsight, rather than identifying a concrete, record-grounded reason a POSITA would have modified Loughran’s disclosed server-driven, printer-side dynamic-adjustment system in the specific manner Petitioner proposes. (Pet. at 10–12; EX1003 ¶48; EX1004 ¶¶[0024]–[0026], [0037]). Petitioner’s remaining “predictable results” rationale is thus conclusory as applied to the specific change Petitioner proposes—importing Dubois’s parameter-determination concepts into Loughran’s networked, server-driven dynamic-adjustment system—

because Petitioner ties “predictable results” to high-level generalities rather than identifying a concrete, compatible integration path that preserves Loughran’s disclosed operating principle of printer-side dynamic adjustment based on server-provided material information. (Pet. at 10–12; EX1003 ¶¶45–48; EX1004 ¶¶[0024]–[0026], [0037]).

87. In my opinion, accordingly, the intrinsic teachings of Loughran and Dubois confirm that Petitioner’s asserted motivation depends on an architecturally inconsistent, expert-driven redesign—rather than a reason a POSITA would have had to modify Loughran in the particular manner Petitioner proposes.

e) Petitioner’s combination renders Loughran inoperable for its intended purpose.

88. In my opinion, combining Loughran and Dubois in the manner proposed by Petitioner would alter the principles of operation of Loughran and render Loughran inoperable for its intended purpose. Loughran’s disclosed solution depends on the printer dynamically obtaining material-linked process parameters from a material-information server and then automatically adjusting printer operation based on those retrieved parameters, including while the system is running. (EX1004 ¶¶[0024]–[0026], [0037]). Petitioner’s proposed redesign instead shifts parameter-setting into the client-generated fabrication job—so that the printer purportedly relies on client-supplied “operational parameters” rather than on Loughran’s server-driven, printer-side parsing and dynamic adjustment—

thereby displacing the very mechanism Loughran teaches to ensure correct, material-appropriate fabrication. (Pet. at 10–12; EX1003 ¶¶45–47; EX1004 ¶¶[0024]–[0026], [0037]). Moreover, once Petitioner shifts parameter-setting into the remote CAD client, the Petition does not show that the client would have (or could keep current) the printer-specific characteristics and deposition-condition inputs that Dubois indicates are needed to generate or validate “optimum values.” (EX1005 ¶¶[0016]–[0017], [0148]–[0156]). As a result, Petitioner’s modified system would either (i) omit the very inputs Dubois deems necessary—and thus would not implement Dubois’s “optimum values” approach as taught—or (ii) require additional, non-disclosed mechanisms to transmit and maintain those printer-side characteristics and conditions at the client. (EX1005 ¶¶[0016]–[0017], [0148]–[0156]; EX1004 ¶¶[0024]–[0026], [0037]). Loughran’s intended purpose is to ensure correct fabrication across different build materials by having the printer retrieve authoritative, machine-readable material parameters from a material-information server and automatically adjust printer settings based on that data. Forcing the CAD client to embed and “select” those parameters in the job would undermine Loughran’s server-based safeguard because the client may not have the most current material database or the printer-specific constraints needed to set correct process parameters, increasing the risk of fabrication defects that Loughran is designed to avoid.

D. Ground 1A Does Not Render Claim 1 Unpatentable

89. Claim 1 requires a networked architecture in which the printer reads tag data from a tag on the build material supply and provides “the data from the tag to the client over the network.” (EX1001, 23:41-43). Claim 1 then requires that the printer “receiv[e] one or more operational parameters from the client selected for use in controlling operation of the three-dimensional printer when fabricating the object with the build material” and that the printer fabricate the object “according to the one or more operational parameters.” (EX1001, 23:44–50).

90. In my opinion, the dependent claims confirm that the claimed “operational parameters” are printer-control settings such as “an extruder temperature,” “a feed rate,” “a build platform temperature,” “a build volume temperature,” “an infill requirement,” “a rafting requirement,” “a support structure requirement,” and “a cooling requirement.” (EX1001, 24:21–26).

1. Petitioner’s element 1[f] theory fails because Loughran teaches printer-side dynamic adjustment based on server-provided material information, not the claimed receipt of client-selected operational parameters used to control the printer during fabrication.

91. For element 1[f], Petitioner relies on Loughran’s disclosure that client devices running CAD software need “information regarding the material” so that SFF fabrication jobs can be “accurately generate[d],” and that the client “parses” the retrieved material information “for using it in SFF fabrication job generation.”

(Pet. at 23–24; EX1004 ¶¶0002], ¶¶0027], ¶¶0043]; EX1003 ¶63). Petitioner further relies on Loughran’s disclosure that CAD software “generat[es] SFF fabrication jobs ... for fabrication from a specific material based on the information regarding that material which has been received,” and then “sends the SFF fabrication job to the second SFF system 104 over the network.” (Pet. at 24; EX1004 ¶¶0055], ¶¶0052], ¶¶0049]; EX1003 ¶64). Petitioner then relies on Dubois’s description of “determining” printing characteristics and “establishing a set of printing parameters” for each print layer/trajectory and treats those “printing parameters” as the claimed client-selected “operational parameters.” (Pet. at 24–26; EX1005 ¶¶0057]–¶¶0059], ¶¶0027], ¶¶0148], ¶¶0150], Claim 79; EX1003 ¶¶65–67).

92. Based on my review, Loughran teaches that information retrieved from the material information server may be in machine-readable form “by which the second SFF system 104 is automatically and dynamically adjusted for utilization with the material 112,” including process parameters such as operating/melting temperature, storage temperature, and inter-layer delay time. (EX1004 ¶¶0024]). Loughran further teaches that the “second SFF system 104 parses the retrieved information regarding the material ... [to] extract parameters ... and dynamically adjusts its own parameters” based on the extracted parameters. (EX1004 ¶¶0037]). Loughran’s disclosure of the printer being “automatically and dynamically adjusted” based on server-provided material information reflects printer-side

selection and application of process settings, not receipt of client-selected operational parameters as recited in element 1[f].

93. That printer-side “automatically and dynamically adjust[ed]” architecture is inconsistent with Petitioner’s element 1[f] premise that the printer instead “receiv[es]” from the client selected operational parameters for controlling printer operation during fabrication. (EX1004 ¶¶[0024], ¶¶[0037]; Pet. at 23–26). Indeed, I note that Dr. Hickner agreed that Loughran’s dynamic adjustment occurs during the run and that the SFF system “just does its own thing in dynamically adjusting,” i.e., adjustment is printer side and not contained in any fabrication job sent by a client. (EX2015, 53:16–54:10). I further note that when Dr. Hickner was pressed to identify a passage in Loughran where “a client transmits to the printer a set of parameters selected for use in controlling printer operation,” he offered no such disclosure and instead speculated that doing so “would have been obvious.” (EX2015, 48:15–51:3). In my opinion, Dr. Hickner’s testimony confirms Petitioner’s theory requires re architecting Loughran away from its server driven, printer side parameter control—not merely combining familiar elements for “predictable results.” I note that Loughran expressly teaches that the printer itself has its own set of information about the material. (EX1004, Fig. 1, ¶¶[0038], [0049]). And as discussed above, it also explains that using such information, the printer is designed to adjust its operation automatically and dynamically for a

material. *Supra* § VII.C; EX1004, ¶¶[0024], [0025], [0035], [0037], [0045], [0048], Fig. 3 at 336. Thus, in my opinion, rather than receiving parameters from a client, Loughran teaches the opposite approach.

94. Accordingly, in my opinion, Petitioner’s mapping does not identify where Loughran discloses the specific step of the printer receiving from the client printer-control “operational parameters” that are “selected for use in controlling operation” of the printer during fabrication, as recited in element 1[f].

2. Dubois does not cure the defect because Dubois’s “optimum values of printing parameters” are determined within the printer-side data processing unit/database, not received from a client as selected operational parameters

95. Based on my review, Dubois describes a device including a printer controlled by a “data processing unit” and a database that “contains ... the choice of optimum values of printing parameters as a function of the nature of the materials, the characteristics of the printer and the deposition conditions.” (EX1005 ¶[0148]–¶[0149]). Dubois’s framework is printer-centric and does not disclose that a remote CAD client selects printer-control operational parameters and transmits them to the printer for use in controlling printer operation during fabrication as claim 1 requires. (EX1005 ¶[0148]–¶[0149]). Dr. Hickner admitted as much during his deposition: Dubois “doesn’t really talk about clients and networks,” and he further admitted Dubois “doesn’t address tags”. (EX2015, 61:13–22; 105:13–22).

96. In my opinion, Petitioner’s theory that Loughran’s CAD job would include Dubois-style parameter selections is therefore an expert-driven overlay that does not identify an actual teaching in Dubois (or Loughran) of the claimed receipt of client-selected operational parameters used to control the printer during fabrication. (Pet. at 23–26; EX1003 ¶¶64–67); *supra* § VII.C. Thus, in my opinion, the combination fails to teach receiving one or more operational parameters from the client selected for use in controlling operation of the three-dimensional printer when fabricating the object with the build material having the at least one property stored in the tag.

* * *

97. Accordingly, it is my opinion that Petitioner has not met its burden to prove claim 1 unpatentable under Ground 1A

E. Ground 1A Does Not Render Dependent Claims 2-5, 7-13, 16, 18, and 20 Unpatentable

98. Dependent claims 2-5, 7-13, 16, 18, and 20 all depend from claim 1, and therefore Ground 1A does not render those dependent claims unpatentable for the reasons discussed above. For the additional reasons discussed below, Ground 1 further fails to teach or suggest the additional limitations of dependent claim 5.

1. Claim 5

99. Claim 5 further requires “receiving a selection of one of the first build material and the second build material from the client for use in fabricating the

object using the three-dimensional printer.” EX1001, 23:64-67. Claim 5 depends from claim 4 (and claim 3), and therefore requires (i) a printer coupled to first and second supplies of different build materials with tags, (ii) providing the data from both tags to the client, and then (iii) “receiving a selection of one of the first build material and the second build material from the client for use in fabricating the object.” (EX1001, 23:53–67).

a) Petitioner’s Ground 1A theory does not show “receiving” a client selection of one of the two tagged build materials.

100. In my opinion, Petitioner’s claim 5 theory is that (i) multi-material printing divides a model into “slices,” (ii) slices “specify a selection of build material,” and therefore (iii) it would have been obvious for Loughran’s fabrication job “received from the client” to include “a selection of the build material.” (Pet. at 29–30). Petitioner asserts that it would have been “obvious to include, in Loughran’s SFF fabrication job received from the client, a selection of the build material for use in fabricating the object and treats that as meeting claim 5’s ‘receiving a selection ... from the client’ requirement. (Pet. at 29–30). Dr. Hickner likewise opines that CAD information in Loughran “would have included a selection of one of the materials for use in fabricating specific portions of the object,” without identifying a disclosure in Loughran or Dubois that the printer

receives a client selection between two tagged supplies after providing tag data for both. (EX1003, ¶79).

b) Petitioner’s theory fails because “slice-level material assignment” is not the claimed step of receiving from the client a selection of one of the two tagged supplies

101. Claim 5 requires that the printer receive from the client a selection of one of the first and second build materials in the context of claims 3–4’s two-supply/two-tag workflow (tag data for both supplies is provided to the client, then a selection is returned). (EX1001, 23:52–67). Petitioner does not identify any disclosure in Loughran or Dubois where the printer provides tag data for two supplies to the client and then receives back a client instruction selecting one of the two tagged supplies for use in fabricating the object. (Pet. at 29–30). Instead, Petitioner’s “obvious to include” assertion is an expert-driven addition to Loughran’s job file, not a teaching in the asserted Ground 1A references of the claimed client-to-printer selection exchange.

c) Petitioner’s “slice” premise is supported by Napadensky (EX1006), which is not part of Ground 1A’s asserted combination

102. In my opinion, Petitioner supports its “slices specify a selection of build material” proposition by citing Napadensky (EX1006), not by identifying a Loughran or Dubois disclosure teaching the claimed client-received selection between two tagged supplies. (Pet. at 30 (citing EX1006 ¶¶[0039]–[0040], [0193]–

[0194])). During his deposition, Dr. Hickner admitted that he relied on Napadensky to explain material assignment at the slice level, even though Napadensky is not part of Grounds 1A/1B. (EX2015, 105:6–12). Because Ground 1A is asserted as Loughran in view of Dubois, I understand that Petitioner cannot rely on Napadensky to supply the missing claim 5 limitation.

d) Dubois does not supply the missing limitation because Dubois’s slicing/parameter determination is printer-centric, not a client-selection step returned to the printer

103. Based on my review, Dubois describes slicing a CAD representation into print layers and determining printing parameters through a device-side data processing unit/database as a function of material nature, printer characteristics, and deposition conditions. (EX1005 ¶¶[0112]–[0116], [0149]–[0150]). Nothing in Dubois teaches that the printer receives from a client a selection between two tagged build-material supplies after the printer provides tag data for both supplies to the client. In fact, Dr. Hickner confirmed that Dubois “doesn’t really talk about clients and networks” and that Dubois “doesn’t address tags,” confirming that Dubois cannot provide the tag to client to selection workflow required by claims 3–5. (EX2015, 61:13–22; 105:13–22). Dr. Hickner also admitted, when speaking about his own experiences, that “in general . . . within [a] slicer program . . . there’s information about the build material in that slicer program. And that’s transmitted over the network to the printer,” and that “it’s entirely possible to transmit material

– or, sorry, transmit a data about a build material over a network in the absence of [a] tag.” (EX2015, 25:17–26:11).

e) **Conclusion**

104. In my opinion, because Petitioner fails to show that Loughran in view of Dubois teaches or suggests claim 5’s requirement of receiving from the client a selection of one of the first and second tagged build materials for use in fabrication—particularly in claim 5’s networked workflow where tag data for multiple supplies is provided to the client and a selection is returned—Petitioner has not met its burden to prove claim 5 unpatentable under Ground 1A.

VIII. GROUND 1B: CLAIMS 1-5, 7-13, 16, 18, AND 20 WOULD NOT HAVE BEEN OBVIOUS OVER LOUGHRAN (EX1004), DUBOIS (EX1005), AND JAZAYERI (EX1010)

105. I understand that in Ground 1B of the Petition, Petitioner asserts that claims 1-5, 7-13, 16, 18, and 20 are obvious over Loughran (EX1004), Dubois (EX1005), and Jazayeri (EX1010). I have reviewed Petitioner’s challenges in Ground 1B, and it is my opinion that Ground 1B fails to teach or suggest all elements of claims 1-5, 7-13, 16, 18, and 20. I explain my opinions below in detail.

A. Overview of *Jazayeri* (EX1010)

106. I have reviewed Jazayeri (EX1010), which discloses a cloud-based print service for two-dimensional printers, such as cloud-aware two-dimensional and legacy two-dimensional printers, that can print on paper in color, black-and-white, and on one or two sides of the paper. *See* (EX1010, Fig. 1, ¶¶[0024], [0027];

see also EX1010 at ¶[0036] (describing “color vs. black-and-white, paper size, orientation, [and] number of copies” as print characteristics); ¶[0070] (“print characteristics may include a designation of one-sided versus two-sided printing, paper size, paper tray, color versus black-and-white”). Jazayeri explains that such printers typically require installing a print driver in an operating system that is specific to the type of printer and operating system. *See* (EX1010 at ¶[0002]). As a result, it may be difficult to create and maintain print drivers for all combinations of printers and operating systems or platforms, or for mobile environments that do not support print drivers. *See* (EX1010 at ¶[0005]). Further, printing documents from web applications is typically a problem because the documents must be converted to a standardized format, such as a PDF document, before predictably printing the document on paper. *See* EX1010 at ¶[0006]. By contrast, *Jazayeri’s* solution addresses these problems by supporting any application to communicate with a cloud print service to print documents, reducing the need for updating or maintaining print drivers. *See* EX1010 at ¶[0028].

B. Jazayeri Is Not Analogous Art

107. As an initial matter, Jazayeri (asserted in Grounds 1B, 1D, 1F, 3B, 3D, 3F, and 3H) is not a proper reference for Petitioner’s obviousness theories because it is not analogous art to the claimed invention. I understand that a reference is

analogous art only if it is either (1) in the same field of endeavor or (2) reasonably pertinent to the particular problem the inventor faced.

a) Petitioner’s reliance on Jazayeri shows why the analogous-art inquiry is dispositive here

108. Ground 1B is “substantively identical” to Ground 1A except for Petitioner’s reliance on Jazayeri to supply claim 1’s “request” requirement (element 1[b]). (Pet. at 33; EX1003 ¶93). Petitioner expressly invokes Jazayeri’s cloud-print workflow—print request → print dialog → selected printer → print job—to create a “request prior to receiving the SFF fabrication job.” (Pet. at 33–34; EX1010 ¶[0036]). Thus, Petitioner’s Ground 1B theory turns on the premise that a POSITA addressing networked three-dimensional printing with tagged build material and material-dependent control parameters would have looked to Jazayeri’s cloud/document-printing paradigm for guidance. (Pet. at 33–35). In my opinion, Jazayeri’s “print request”/“print job” framework and its “print characteristics” (paper size, orientation, number of copies, etc.) are rooted in 2D document printing and do not address material-dependent process-control issues that drive 3D fabrication.

b) Jazayeri is outside the ’466 Patent’s field of endeavor

109. The ’466 Patent is directed to three-dimensional printing using tagged build materials and using tag-derived build-material information/properties to determine operational parameters for fabrication. (EX1001, 1:23-33, 20:61–22:33).

In my opinion, a POSITA working on tagged build materials and material-dependent fabrication control in 3D printing would not reasonably consult a cloud-based 2D print-service reference centered on printer registration and paper/ink settings, because it does not speak to melt/curing behavior, support/infill generation, or other 3D process controls.

110. The '466 Patent's networked environment is described in the context of three-dimensional printers, tag sensors reading tag data, and a controller that may be associated with a remote resource within a networked three-dimensional printing environment. (EX1001, 1:23-33, 20:61–22:33). By contrast, Jazayeri describes a cloud-based print service/print server paradigm in which an application manager receives print requests and manages print jobs in a conventional printing environment. (EX1010 ¶¶[0008]–[0010], ¶¶[0019]–[0021]). Jazayeri's print-job construct focuses on conventional "print characteristics" such as paper size, orientation, and number of copies. (EX1010 ¶¶[0036]). Petitioner itself acknowledges this field mismatch by stating that "Jazayeri describes a networked printing environment with respect to 2D printers." (Pet. at 36). Dr. Hickner likewise admitted that Jazayeri "doesn't explicitly say three dimensional printing" and is focused on 2D printing (paper size, orientation, copies). (EX2015, 88:7–89:3, 91:19–92:1). He also confirmed that Jazayeri's "request" is received at a server, not by any three dimensional printer. (EX2015, 88:7–89:3).

c) Jazayeri is not reasonably pertinent to the problem the '466 patent addresses

111. The '466 patent addresses problems tied to material-dependent fabrication in three-dimensional printing—using tag data/identifiers to obtain build-material information and determine operational parameters for fabrication using that build material. (EX1001, 20:61–22:33). Jazayeri is instead directed to issues associated with “conventional printers and printing paradigms,” and proposes a cloud-based print-service solution to improve that user experience. (EX1010 ¶¶[0007], [0019]–[0021]; Inst. Dec. at 22). Jazayeri’s teachings (print dialogs, registered-printer selection, and paper/ink print characteristics) are not directed to—and do not address—the '466 Patent’s tagged-build-material problem of selecting/deriving operational parameters for control of three-dimensional fabrication based on build-material identity/properties. (EX1010 ¶¶[0019]–[0021], [0036]). Petitioner’s reliance confirms the disconnect because Petitioner uses Jazayeri primarily to add a pre-job “request” layer rather than for any material-tag or fabrication-parameter teachings pertinent to the '466 patent’s problem.

d) Petitioner’s “POSITA is not an automaton” rhetoric does not establish analogous art

112. I understand that Petitioner asserts that although Jazayeri concerns 2D printing, a POSITA “was not an automaton” and would have had ample skill to incorporate Jazayeri into Loughran’s system. (Pet. at 36). However, I note that

neither Petitioner nor Dr. Hickner provide any analysis or evidentiary support for this conclusion. (Pet. at 36; EX1003 ¶48). Petitioner’s claimed “benefits” likewise track Jazayeri’s cloud-print paradigm (platform-independent printing to registered printers via a cloud service), which is a different problem set than the ’466 patent’s build-material tagging and operational-parameter control for fabrication. (Pet. at 34–36; EX1010 ¶[0008]–[0011]).

e) **The full record supports finding that Jazayeri is not analogous art**

113. I understand that at institution, the Board stated it would not conflate the level of ordinary skill with the analogous-art inquiry and found Petitioner had sufficiently established analogous art “at this stage.” (Inst. Dec. at 23). On the full record, the documents themselves underscore the field and problem disconnect—Jazayeri’s cloud/document-printing focus on print dialogs, registered printers, and paper/ink print characteristics versus the ’466 Patent’s focus on tagged build materials and operational-parameter control for three-dimensional fabrication. (EX1010 ¶¶[0019]–[0021], [0036]). Because Ground 1B depends on importing Jazayeri’s cloud-print request paradigm to supply claim 1[b], and because that paradigm is not directed to the ’466 Patent’s problem, Jazayeri is not the type of reference a POSITA would reasonably consult in this context.

C. No motivation to combine references in Grounds 1A (*Loughran and Dubois*) and 1B (*Jazayeri*)

1. Petitioner's asserted motivation

114. In my opinion, Petitioner presents Ground 1B as an alternative theory that adds Jazayeri “to the extent that Loughran’s SFF fabrication job ... is not considered a request.” (Pet. at 33). Petitioner asserts a POSITA would modify Loughran so the SFF printer receives a “request prior to receiving the SFF fabrication job” by importing Jazayeri’s cloud-print workflow (print request → print dialog → selected printer → print job). (Pet. at 42–43; EX1010 ¶¶[0036]; EX1003 ¶¶[94–95]). Petitioner further asserts the combination would provide benefits such as increased printing options, platform independence, and reduced cost/complexity of printer-driver paradigms. (Pet. at 34–46; EX1010 ¶¶[0008]–[0010], [0019]–[0021]; EX1003 ¶¶[96–100]). In my opinion, adding Jazayeri’s GUI/account-driven printer-selection workflow to Loughran would introduce layers that are irrelevant to Loughran’s SFF job exchange and would not improve—and would potentially complicate—the material-parameter control that is central to Loughran.

2. Loughran already provides the “networked job submission” concept Petitioner attributes to Jazayeri

115. Loughran discloses a networked system in which a first SFF system (with CAD software) and a second SFF system are connected via a network, and the first system sends SFF fabrication jobs to the second system for fabrication.

(EX1004 ¶¶[0049]–[0052]). Because Loughran already discloses networked submission of fabrication jobs, Petitioner’s asserted “need” to add Jazayeri’s cloud-print request layer is not tied to any deficiency in Loughran’s disclosed job-submission architecture.

3. Jazayeri targets a different printing paradigm than Loughran’s SFF fabrication-job workflow

116. Jazayeri is directed to a cloud print service addressing conventional-printing paradigms and relies on user-interface printer selection and print-job characteristics such as paper settings. (EX1010 ¶¶[0019]–[0021], [0036]). Loughran’s workflow, by contrast, is centered on SFF fabrication jobs exchanged between SFF systems and on printer-side use of material information to enable and control fabrication. (EX1004 ¶¶[0024]–[0026], [0037], [0049]–[0052]). Petitioner’s rationale does not explain why a POSITA would graft Jazayeri’s UI-driven cloud-print request framework onto Loughran’s SFF fabrication-job workflow merely to add a pre-job “request.” (Pet. at 34–36; EX1010 ¶[0036]; EX1004 ¶¶[0049]–[0052]).

4. The proposed overlay is in tension with the printer-side parameter-control teachings of Loughran and Dubois

117. Based on my review, Loughran teaches printer-side, automatic/dynamic adjustment of fabrication parameters based on material information retrieved (including process parameters such as melting temperature

and inter-layer delay time). (EX1004 ¶¶[0024]–[0026], [0037]). Dubois teaches selecting “optimum values of printing parameters” as a function of the material and the characteristics of the printer, implemented through device-side processing and a database. (EX1005 ¶¶[0148]–[0149]).

118. In my opinion, Petitioner’s asserted benefits for adding Jazayeri emphasize “platform-independent” and “not printer specific” cloud printing, which is in tension with Dubois’s printer-characteristics-dependent parameter selection and Loughran’s printer-side dynamic adjustment. (Pet. at 34–36; EX1010 ¶¶[0008]–[0010], [0019]–[0021]; EX1005 ¶¶[0148]–[0149]; EX1004 ¶¶[0024]–[0026], [0037]). Petitioner does not explain why a POSITA would be motivated to introduce Jazayeri’s printer-agnostic cloud-print paradigm into a system whose combined teachings rely on printer-specific and printer-side parameter determination.

5. Petitioner’s stated “benefits” are generic to cloud printing and do not provide a reason to modify Loughran’s SFF system in the manner proposed

119. In my opinion, Petitioner ties its alleged benefits (increased printing options/abilities, platform-independence, reduced cost of drivers) to Jazayeri’s cloud print service enabling applications on devices to printers in communication with the cloud service. (Pet. at 34–36; EX1010 ¶¶[0008]–[0010], [0019]–[0021]). Those benefits are described in Jazayeri as improvements to conventional printing

paradigms and are implemented through cloud-print workflows involving print dialogs, registered printers, and user accounts, rather than through Loughran’s SFF job exchange and printer-side dynamic process-parameter adjustment. (EX1010 ¶¶[0019]–[0021], [0036]; EX1004 ¶¶[0024]–[0026], [0049]–[0052]). Accordingly, Petitioner’s Ground 1B motivation relies on general cloud-printing advantages, but those asserted advantages do not supply a reason—grounded in the teachings of Loughran and Dubois—to graft Jazayeri’s cloud-print request and UI selection framework onto Loughran’s SFF fabrication-job workflow as Petitioner proposes.

D. Ground 1B Does Not Render Claim 1 Unpatentable

120. Ground 1B “incorporates” Ground 1A “in all but one respect,” and relies on the “additional disclosure of Jazayeri” only to address element 1[b]’s “request” requirement. (Pet. at 33; EX1003 ¶¶93-100). Accordingly, Ground 1B fails at the outset for the same independent reason Ground 1A fails—Petitioner’s incorporated Ground 1A showing does not establish element 1[f]’s requirement of “receiving one or more operational parameters from the client selected for use in controlling operation of the three-dimensional printer when fabricating the object with the build material having the at least one property stored in the tag.” *See supra* § VII.D.

121. In my opinion, independently, Ground 1B fails because Petitioner’s only asserted basis for satisfying element 1[b] is to import Jazayeri’s

cloud/document-printing “print request” paradigm into the Loughran–Dubois system. (Pet. at 33–34; EX1010 ¶¶0036; EX1003 ¶¶75–76). As explained *supra* § VIII.B, Jazayeri is not analogous art to the ’466 Patent’s tagged-build-material and operational-parameter-control framework (including its use of tag data to determine operational parameters for fabrication in a networked three-dimensional printing environment), and Petitioner therefore cannot rely on Jazayeri as the sole “fix” for element 1[b]. *See supra* § VII.B.

122. In my opinion, finally, as explained *supra* § VIII.C, Petitioner’s asserted motivations for combining rest on generic cloud-printing benefits and are not anchored to any deficiency in Loughran’s disclosed networked SFF fabrication-job submission or printer-side parameter-control architecture (as further shaped by Dubois’s printer-characteristics-dependent optimization), such that Petitioner fails to establish the requisite motivation to combine. *See supra* § VIII.C.

123. In my opinion, accordingly, for at least the foregoing reasons, Petitioner has not met its burden to prove claim 1 unpatentable under Ground 1B.

E. Ground 1B Does Not Render Dependent Claims 2-5, 7-13, 16, 18, and 20 Unpatentable

124. I understand that Petitioner states that, other than claim element 1[b], “the analysis of all other claim elements is identical” to Ground 1A. (Pet. at 33). Accordingly, Ground 1B does not render Dependent Claims 2-5, 7-13, 16, 18, and 20 unpatentable for the reasons discussed previously for Ground 1A. *Supra* VII.

IX. GROUND 2: CLAIM 19 WOULD NOT HAVE BEEN OBVIOUS OVER DEVOS (EX1008)

125. I understand that in Ground 2 of the Petition, Petitioner asserts that claim 19 is obvious over Devos (EX1008). I have reviewed Petitioner's challenges in Ground 2, and it is my opinion that Ground 2 fails to teach or suggest all elements of claim 19. I explain my opinions below in detail.

A. Overview of *Devos* (EX1008)

126. I have reviewed *Devos* (EX1008), which discloses improved powder supply bins for solid freeform fabrication. EX1008, Title. The system includes a removable powder supply bin, a build bin, a roller, and a print head above the build bin that deposits a binder onto the powder in the build bin in a preselected pattern. *Id.* at Abstract.

127. *Devos* explains that “[o]bjects are fabricated by printing or ejecting an adhesive or binder onto a flat bed of powder. Where the binder is ejected, the powder is solidified into a cross section of the object being formed.” *Id.*, ¶[0001]. The reference is directed to “a solid freeform applicator that is easier and less messy to use” and changing powder types via a removable bin. *Id.*, ¶¶[0003], [0011].

128. As shown below in Figure 2 of *Devos*, the system includes a supply bin 110 next to a build bin 102.

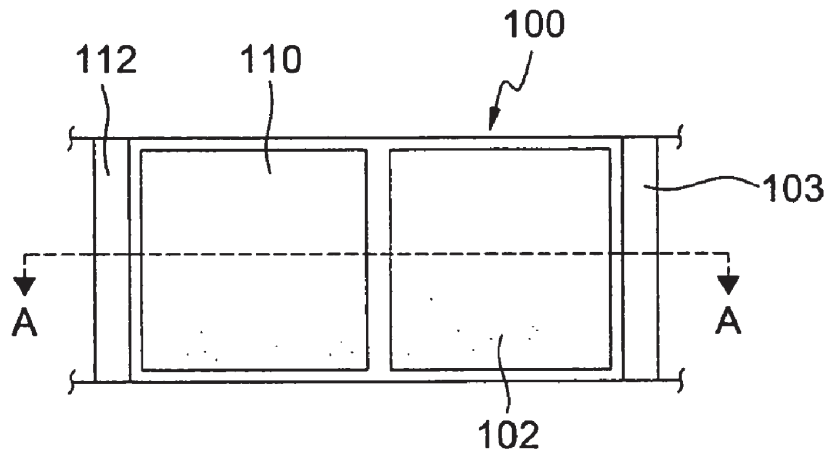


FIG. 2

Id. at Fig. 2. The top view also shows a roller 112 that traverses supply bin 110 to move a very thin layer of powder from the top surface of the supply bin 110 onto a platform of the build bin 102. *Id.*, ¶[0019]. After the powder is moved, a print head 103 deposits binder onto the powder to form one layer of the object. *Id.* Devos explains that his supply bin 110 is designed to be easily removable from the system and thus can be reused for another fabrication or disposed. *Id.*

129. Devos also illustrates the operation of a supply powder bin in Figure 3:

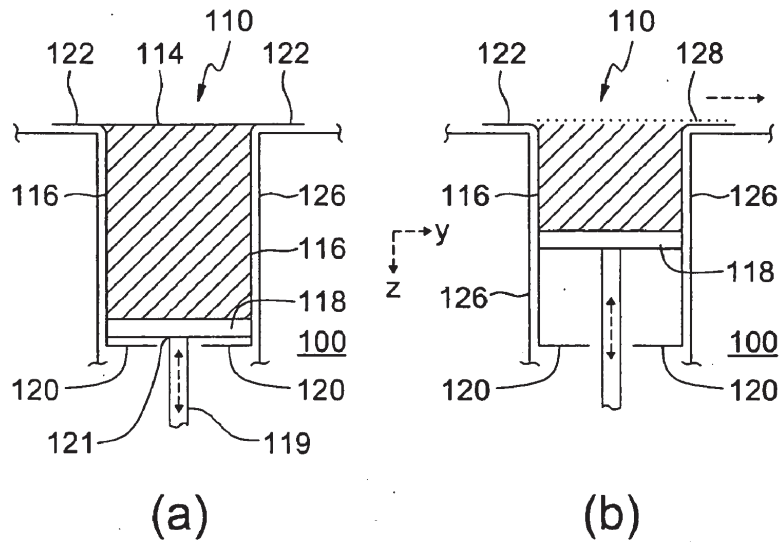


FIG. 3

Id. at Fig. 3. In particular, Figure 3(a) shows supply bin 110 when first placed in the system and Figure 3(b) shows supply bin 110 when powder 128 is partially deployed. As shown, the supply bin has a removable top, side walls, and a piston-like bottom that supports and feeds the powder to the roller during printing. *See id.*, ¶[0011].

130. Devos also discloses a flow diagram in Figure 6 that shows the operations for powder-based printing.

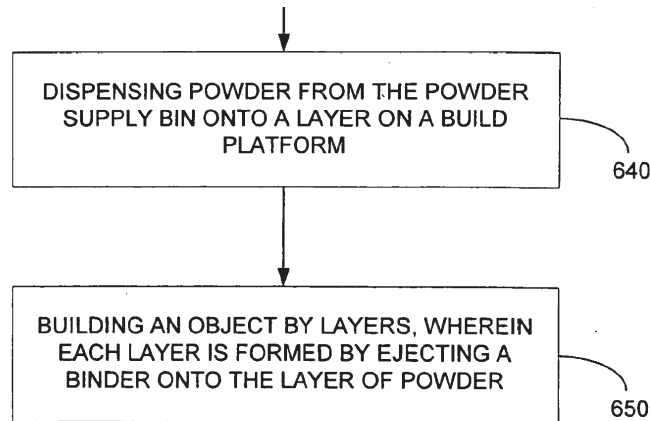


FIG. 6

Id. at Fig. 6 (excerpt). At step 640, powder is dispensed from the powder supply bin onto a layer on a build platform. *Id.*, ¶[0035]. And at step 650, the object is built in layers, where each layer is formed by ejecting a binder from a print head onto the powder that is on the build platform. *See id.* In this manner, the binder (also referred to as an adhesive) binds the adjacent or successive layers of the object together. *See id.*, ¶[0015]. Once the entire object is formed, Devos explains that the extra powder that is not bonded by the binder is “brushed away” leaving the base or “green” object. *Id.*

B. Ground 2 Does Not Render Claim 19 Unpatentable

131. Claim 19 expressly requires “determining an operational parameter ... the operational parameter including at least one of a build platform temperature, a build volume temperature, an infill requirement, a rafting requirement, a support structure requirement, and a cooling requirement.” (EX1001 at claim 19).

132. The '466 Patent likewise explains that a controller may use the build-material information to determine multiple distinct “operational parameters,” including (among others) “a rafting requirement” and separately “a support structure requirement,” confirming that “support structure requirement” is a specific type of claimed operational parameter—not merely any printing variable. (EX1001 at 21:56–61).

1. Petitioner’s element 19[e] theory hinges on recharacterizing Devos’s “powder settling coefficients” as the claimed “support structure requirement”

133. For element 19[e], I understand that Petitioner relies on Devos’s statement that the “system can also use the data encoded in or on the memory mechanism 146 to determine certain operating parameters,” listing examples including “powder settling coefficients (e.g., to determine whether powder supports need to be included, and if so, how much support).” (Pet. at 49; EX1008 ¶[0032]). Petitioner then asserts that, “[b]ased on Devos’s disclosure” of those powder-settling coefficients, a POSITA “would have been motivated to implement Devos’s system to determine an operating parameter specifying whether and how much powder supports are needed (a support structure requirement).” (Pet. at 49). Petitioner’s expert repeats this same theory, opining that Devos’s parenthetical reference to “how much support” would have “indicated to a POSITA that the system would need to generate a parameter indicating ‘how much support’ material

to use,” and that this purportedly “provides the claimed support structure requirement.” (EX1003 ¶113). In my opinion, a POSITA would understand a “support structure requirement” as an operational parameter would specify whether/where supports should be generated and printed and with what settings, which is not taught by Devos’s generic reference to “powder settling coefficients” that may be used to decide whether “powder supports” are needed.

2. Petitioner’s theory fails because Devos does not disclose any claimed “support structure requirement,” nor any other element-19[e] enumerated parameter

134. Devos’s cited passage lists example “operating parameters” such as “print speed,” “drop volume per voxel,” “color maps,” “dry time needed after build completion,” “shrink or expansion size,” “adjustment factors,” “powder settling coefficients,” and “minimum allowable layer thickness.” (EX1008 ¶[0032]). None of Devos’s listed operating parameters is a “build platform temperature,” “build volume temperature,” “infill requirement,” “rafting requirement,” “support structure requirement,” or “cooling requirement,” as required by claim 19. Accordingly, Petitioner’s satisfaction of element 19[e] depends entirely on its attempt to equate Devos’s “powder settling coefficients” (and a parenthetical about “powder supports”) with claim 19’s “support structure requirement.” (Pet. at 49; EX1008 ¶[0032]; EX1003 ¶113).

135. In my opinion, however, Devos never discloses determining (from the tag/memory data) a support-structure setting/requirement that configures the printer to fabricate support structures (or to require them) as part of the build—Devos discloses only a “powder settling coefficient,” offered as one example among many operating parameters. (EX1008 ¶[0032]). In my professional opinion, Devos’s “supports” parenthetical is unrelated to 3D printed supports. It is, at most, an aside related to potential use of a settling coefficient to inform decisions about thermal post-processing support requirements that could take place after the component has been three-dimensionally printed. Devos still does not disclose that the system determines (from the memory mechanism) an operational parameter that is a “support structure requirement,” much less one that configures the printer to generate “support structures” as a distinct operational requirement.

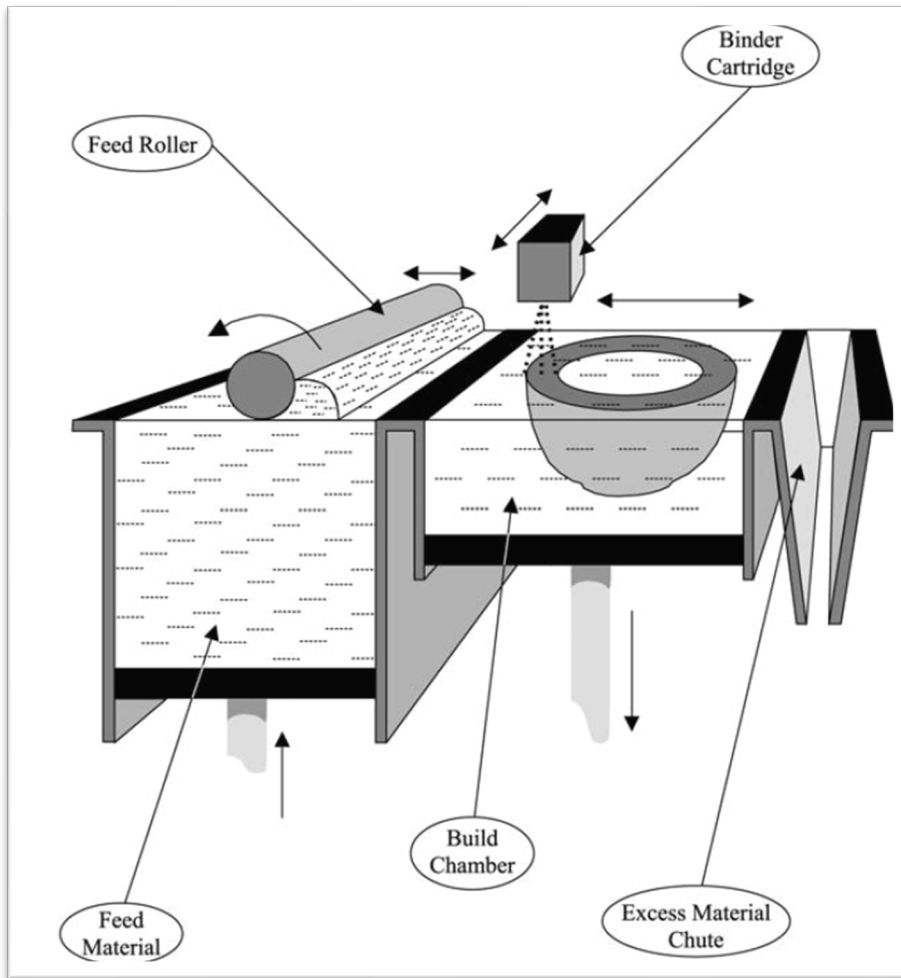
3. Petitioner’s “implement Devos to generate a support-structure parameter” theory is an expert-driven redesign untethered to Devos

136. In my opinion, Petitioner’s theory is not that Devos discloses a claimed “support structure requirement,” but rather that a POSITA “would have been motivated to implement Devos’s system” to “determine an operating parameter specifying whether and how much powder supports are needed.” (Pet. at 49).

137. Dr. Hickner’s declaration confirms this is an added-to-Devos construct—he asserts the POSITA “would need to generate a parameter indicating

‘how much support’ material to use,” and that the POSITA would do so “to prevent portions of the object from collapsing during fabrication.” (EX1003 ¶113). But Devos describes a binder jetting powder-bed process in which each cross-section is formed by depositing binder into successive powder layers until “the entire object is formed within the powder bed in the build bin 102.” (EX1008 ¶¶[0013]–[0015]). Because Devos forms the entire object within the powder bed, Devos neither identifies an unsupported-geometry collapse problem nor teaches generating any “support-structure parameter” to address it—Petitioner supplies that missing requirement only through expert say-so.

138. In the binder jetting process employed by Devos, a thin layer of powder is first spread out. An inkjet print head then selectively jets droplets of binder, or “glue”, over those regions of the powder layer that need to be solidified. Areas outside of regions where binder is printed remain in loose powder form. A second layer of powder is spread on top of the first layer, and the process is repeated one layer after another until the final layer is completed. (EX1008, ¶¶[0013]–[0015]; EX2014 at pp.335-327). A POSITA would have understood that in Devos’ binder jetting process, components being printed are surrounded and supported by the bed of powder where no binder was printed. This process is shown in the following image from Upcraft, S. and Fletcher, R., 2003. *The rapid prototyping technologies. Assembly Automation*, 23(4), p.318-330:



(EX2014 at p.327). A POSITA would understand that printing of rigid support structures is therefore not needed due to the fact that the loose powder surrounding the part provides the necessary support. Indeed, the same article explains that one of the “advantages” of Devos’s type of additive manufacturing is that “[n]o support structures allow complex geometry to be created.” (EX2014 at p.326). In attempting to equate powder supports with the need to “prevent portions of the object from collapsing during fabrication” (EX1003 ¶114) Hickner avoids saying “during three-dimensional printing.” This is because the potential for “collapse” is associated with

an entirely different manufacturing process (thermal processing in a furnace) that can optionally be performed on metallic parts in a different machine after the three-dimensional binder jet printing process has been completed. Thus, mention of a support requirement in Devos is for a different manufacturing process than three-dimensional printing, and Devos does not teach a support structure requirement for use in controlling operation of the three-dimensional printer. Simply put, parts fabricated via Devos's methods do not collapse during the 3D printing fabrication process, and a POSITA would understand that the "support structure requirement" implicated in fused filament fabrication printing as described in the '466 Patent is not implicated for the methods described in Devos.

139. Devos makes one single mention of a "powder settling coefficient" in connection with binder jetting. A powder settling coefficient is a characteristic of the powder that indicates how much a given powder will settle down, or compact, when it is spread out and/or when droplets of liquid binder are jetted onto it. The powder settling coefficient by itself is insufficient to determine whether or not support structures are needed for thermal post-processing after three-dimensional printing is completed. A numerical powder settling coefficient is therefore not "a support structure requirement". Furthermore, any use of a powder settling coefficient together with other information, such as part geometry and the strength of the material, to compute a post-processing support structure requirement would

involve expert level knowledge that would be well beyond the knowledge base of a POSITA. In fact, I note that Dr. Hickner acknowledged Devos provides “no technical detail” on how any support structure requirement would be derived from a settling coefficient. (EX2015, 121:2–10; 122:1-3). And when asked yes/no whether a “powder settling coefficient” is an ’466 “operational parameter,” he refused to commit, stating: “I mean, we're talking about, you know, complicated details of additive manufacturing and powders.... It’s not a simple yes or no answer ... I could do that analysis, but I haven’t done it.” (EX2015, 117:8 – 120:19).

140. In my opinion, nothing in Devos’s cited disclosures explains (i) what a “support structure requirement” would be in Devos’s system, (ii) how it would be derived from the memory-mechanism data, or (iii) how the printer would be configured or controlled to fabricate “support structures” based on that derived requirement. (Pet. at 49; EX1008 ¶¶0032]; EX1003 ¶113).

141. Furthermore, I understand that because Ground 2 relies on Devos alone, Petitioner must also show that Devos—together with any proven background knowledge—would have enabled a POSITA to make and use the claimed “support structure requirement” without undue experimentation. However, as discussed above, Petitioner offers no such evidence or reasoned analysis, and I disagree that any such “support structure requirement” could be derived without undue experimentation by a POSITA. (Pet. at 49; EX1003, ¶113).

4. Conclusion

142. In my opinion, because Petitioner fails to show that Devos teaches, renders obvious, or enables element 19[e]’s requirement that the determined operational parameter include at least one of the enumerated items—specifically a “support structure requirement”—Petitioner has not met its burden to prove claim 19 unpatentable under Ground 2.

X. GROUND 3A: CLAIMS 1, 3-5, 7, 9-11, 19, AND 20 WOULD NOT HAVE BEEN OBVIOUS OVER MENCHIK (EX1009)

143. I understand that in Ground 3A of the Petition, Petitioner asserts that claims 1, 3-5, 7, 9-11, 19, and 20 are obvious over Menchik (EX1009). I have reviewed Petitioner’s challenges in Ground 3A, and it is my opinion that Ground 3A fails to teach or suggest all elements of claims 1, 3-5, 7, 9-11, 19, and 20. I explain my opinions below in detail.

A. Overview of *Menchik* (EX1009)

144. I have reviewed Menchik (EX1009), which discloses three-dimensional object printing. EX1009 at Title. The system includes cartridges with modeling models that are connected via valves for dispensing material. *Id.* at Abstract, Fig. 1 (reproduced below).

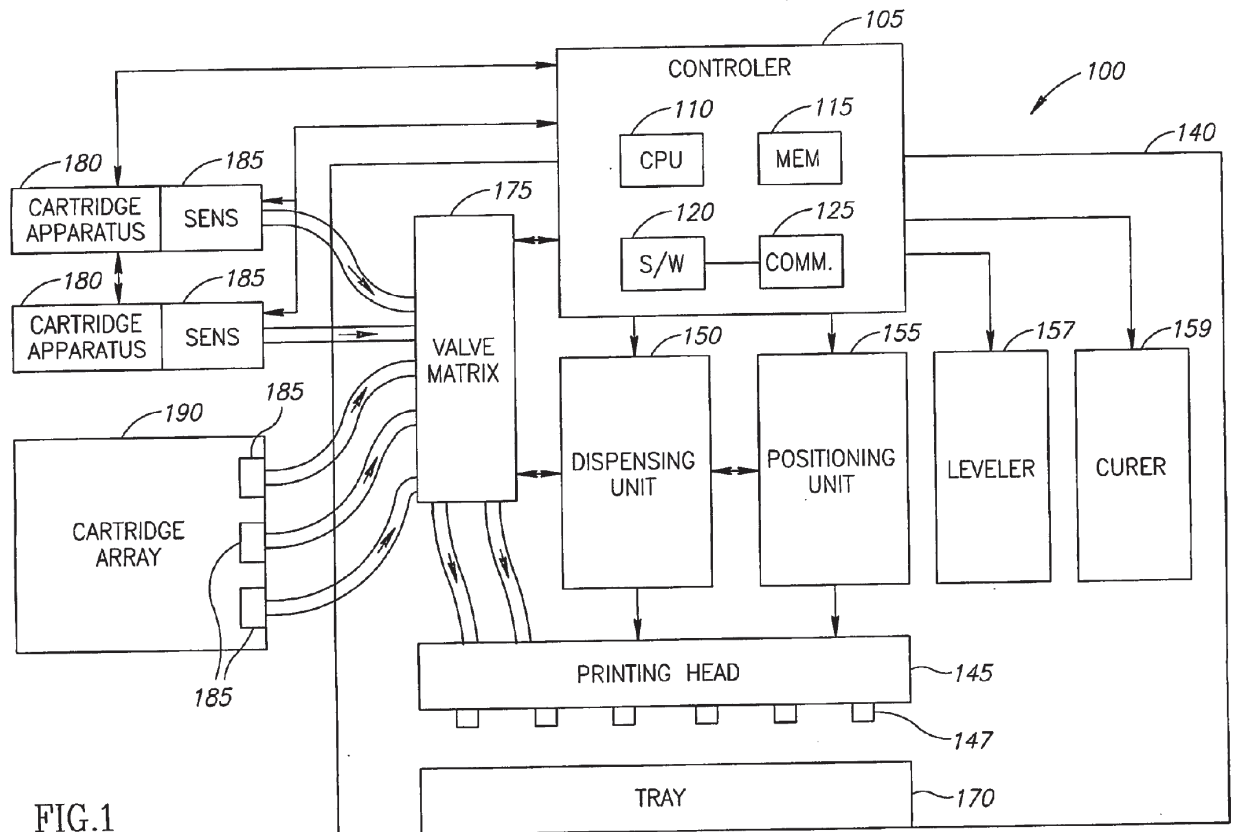


FIG.1

Sensors associated with the cartridges can monitor the status of the material, and a controller receives data from the cartridges and computes supply parameters for the materials. *Id.*

B. Overview of *Dahlin* (EX1011)

145. I have reviewed *Dahlin* (EX1011), which discloses a rapid prototyping system that forms three-dimensional objects using filament supplied from a spool having an associated circuit that maintains data regarding the type and amount of filament on the spool. (EX1011 at 1:13–17). *Dahlin* teaches that a processor board receives filament information from a filament sensor and an EEPROM board attached to the filament spool. (EX1011 at 5:1–10). *Dahlin* explains that the

EEPROM board “acts as an electronic tag” that informs the control system of the type of filament on the spool and the lineal feet of filament on the spool. (EX1011 at 5:7–13). Dahlin further explains that the CPU tracks how much material is commanded to be extruded, subtracts that amount from the total stored on the EEPROM, and writes an updated value back to the EEPROM. (EX1011 at 5:13–17). Dahlin discloses that, at the outset of a job, the CPU calculates whether a modeling or support spool contains enough filament to complete the job and provides operator notification indicating adequacy or the need for replacement/reloading. (EX1011 at 5:25–32).

C. Ground 3A Does Not Render Claim 1 Unpatentable

146. As I discuss below, Petitioner fails to show that Menchik discloses or teaches each of the elements of claim 1 and thus the reference does not anticipate or render obvious the claim.

147. I understand that the Board instituted review on Ground 3A, accepting Petitioner’s premise that Menchik’s “controller 105” can be the claimed “client,” and that Menchik’s “computing platform connected to [the] 3D printer system” is an embodiment of that controller such that the “printing file” is a “request” sent from the “client” to the printer. (Inst. Dec. at 31–33; Pet. at 57–59; EX1009 ¶¶[0024]–[0026]; EX1003 ¶¶129–130). Respectfully, that premise is inconsistent with claim 1’s structure and the intrinsic evidence, and it collapses ’466 Patent’s

distinct “controller” and “client” roles into a single component in a manner that Menchik does not teach.

1. Menchik does not teach element 1[b] because claim 1’s “client” is distinct from the printer’s controller, and Menchik’s “controller 105” is a printer-controller component—not a client device that sends a fabrication request

148. Claim 1 requires “receiving a request from *a client* over a network to fabricate an object on the three-dimensional printer,” whereas claim 19 specifically recites “providing a three-dimensional printer that includes *a controller*,” confirming that the claimed “client” is not the printer’s own controller. (EX1001 at claims 1, 19). The specification similarly describes “client device 206” as a device “operated by users to initiate, manage, monitor, or otherwise interact with print jobs at the three-dimensional printers,” reinforcing that the “client” is a user-facing device external to (and interacting with) the printer(s), not the printer’s internal controller. (EX1001 at 5:40–46). In networked additive-manufacturing systems the “client” is typically a separate computing device that submits a job/request over a network, whereas an internal “controller” inside the 3D printer executes that job and directly actuates motors, heaters, dispensers, and other subsystems. A POSITA would understand that regardless of whether it is physically inside of or nearby the 3D printer, the machine controller is not a networked client device. Simply put, the 3D printer cannot operate without a controller. A POSITA would therefore clearly understand that the controller is functional part of the 3D printing system. If the

machine controller that is part of the 3D printer were simultaneously considered to be a networked client, then sending a print job and/or any other data over a network to itself makes no sense (i.e. the controller that already has the print job would not “send” the print job to itself). I note that Fig. 2 in the ‘466 Patent illustrates multiple client devices communicating with multiple 3D printers via a network, which further supports the way a POSITA would differentiate between functions of a networked client device and a 3D printer machine controller. EX1001 at Fig. 2. I further understand that during his deposition, Dr. Hickner admitted that he did not analyze whether the terms “client” and “controller” can be equated in the context of the ’466 patent, admitting “I didn’t analyze ... whether or not controller and client can be equated” (EX2015, 16:22 – 18:11).

149. Based on my review, Menchik, by contrast, describes “controller 105” as a control component that “may receive data from one or more material supply sources, and control the supply of building material to printing apparatus 140,” i.e., it is disclosed as a system controller for printer operation and material delivery. (EX1009 ¶[0027]). Menchik also expressly discloses an embodiment where controller 105 is “located inside printing apparatus 140,” which is the opposite of a “client device” that is operated by users to interact with print jobs at 3D printers over a network. (EX1009 ¶[0024]; Pet. at 57–58 (citing EX1009 Fig. 1, ¶[0024])).

150. I understand that the Board nevertheless reasoned that because claim 1’s “client device” may “include desktop computers, laptop computers, network computers, [or] tablets,” and because Menchik says controller 105 “may be included within, or may include, a computing device such as a personal computer [or] laptop,” controller 105 can satisfy the “client” limitation. (Inst. Dec. at 32–33 (quoting EX1001 at 5:40–46 and EX1009 ¶[0026])). However, the intrinsic evidence does not equate “any computing device” with the claimed “client”; it ties the “client device” to the user-operated role of initiating/managing/monitoring print jobs “at the three-dimensional printers,” which is a distinct role from Menchik’s printer-control functionality attributed to controller 105. Menchik’s statement that controller 105 may be implemented using a PC-class device describes a possible hardware implementation for a controller that provides “printing system control capability,” not a disclosure that the printer receives a client request from such a device in the manner claim 1 requires. (EX1009 ¶[0024]).

151. In my opinion, Petitioner’s “request” mapping likewise depends on this same improper “controller-as-client” recharacterization. (Pet. at 58–59; EX1003 ¶¶129–130). Petitioner relies on Menchik’s disclosure that “a printing file ... may be ... provided ... by a computing platform connected to 3D printer system 100” and asserts that “the printing file provided by the controller of the computing device (client) to the printing apparatus ... is a request.” (Pet. at 58–59; EX1009 ¶[0025];

EX1003 ¶¶129–130). However, Menchik does not say that the “computing platform” is the claimed “client” (as claim 1 uses that term), nor does Menchik disclose that the printer “receiv[es] a request from a client over a network” as opposed to simply using a “printing file” prepared by a connected computing platform as part of its internal workflow. (EX1009 ¶[0025]). A file can be created and transferred without initiating fabrication until a separate start/build command is issued to the printer.

152. I understand that the Board concluded that the “computing platform connected to 3D printer system” is an embodiment of controller 105 because Menchik teaches controller 105 “may be partially external” as an “external control or processing unit (e.g., a ... computing platform ...).” (Inst. Dec. at 32 (quoting EX1009 ¶[0024])). Even accepting that controller 105 can be partially external, Menchik’s disclosure is that any such external unit “may provide some or all of the printing system control capability,” which again describes the controller function—not a user-operated “client” sending a fabrication request as in claim 1. (EX1009 ¶[0024]).

153. In my opinion, finally, to the extent Petitioner relied on an “at least suggests” theory that a wired/wireless connection could be implemented “over a network,” that is not an anticipation disclosure and does not cure the absence of

Menchik teaching claim 1’s “request from a client over a network” framework in the first place. (Inst. Dec. at 31; Pet. at 57–59).

2. Menchik does not teach element 1[e] because it does not disclose “providing the data from the tag to the client over the network”

154. Element 1[e] requires “providing the data from the tag to the client over the network.” (EX1001 at claim 1). The Board accepted Petitioner’s position that “transmitting data to [a] printer controller” from a memory chip storing build-material information satisfies providing tag data “to the client,” given its earlier conclusion that controller 105 is the “client.” (Inst. Dec. at 33; Pet. at 60–61). However, Menchik’s cited disclosures describe transmitting information from a cartridge memory mechanism/chip to the controller so the controller can compute or use parameters for printing and material supply, not providing tag data client device over a network. (Pet. at 60–62; EX1009 ¶¶[0027], [0047]–[0048]). Thus, Petitioner’s element 1[e] mapping likewise fails due to a mistaken conflation of Menchik’s printer controller with claim 1’s “client.”

3. Menchik does not teach element 1[f] because the asserted “operational parameters” are not “receiv[ed] ... from the client selected for use” as claim 1 requires

155. Element 1[f] requires “receiving one or more operational parameters from the client selected for use in controlling operation of the three-dimensional

printer when fabricating the object with the build material having the at least one property stored in the tag.” (EX1001 at claim 1).

156. I understand that Petitioner contends this is met because “printing apparatus 140 ... receives the printing file and ... printing parameters, operation parameters, building parameters, material parameters, and supply parameters ... from the controller 105 in the computing device (client) over a network.” (Pet. at 63; EX1003 ¶137). However, Menchik’s cited workflow is that controller 105 uses data from sensors and cartridge memory chips to compute “material parameters” and “supply parameters,” including computing quantities/availability and determining whether/when/how much material to extract according to printer requirements for a particular object. (EX1009 ¶¶[0027], [0047]–[0048]). That is the opposite of claim 1’s requirement that the printer receives operational parameters “from the client selected for use,” which presupposes a client-side selection informed by tag data (element 1[e]) and then a receipt of those selected parameters by the printer. (EX1001 at 5:40–46, claim 1).

157. In my opinion, moreover, while Petitioner concludes that the printer “receives the printing file and the printing parameters, operation parameters, building parameters, material parameters, and supply parameters (collectively operational parameters) from the controller 105” (Pet. 63), it fails to explain which printing file, printing parameters, operation parameters, building parameters,

material parameters, and supply parameters are allegedly received. On this point, the Board relied on the specification's statement that "operational parameters" may include any "operational parameter that might usefully be determined by the controller from the data stored by the data tag 304," and reasoned that this "broad scope" does not exclude Menchik's "printing file." (Inst. Dec. at 34 (quoting EX1001 at 15:17–24); EX1009 ¶[0025]). However, even if "operational parameter" is broad in the abstract, element 1[f] is not satisfied unless those parameters are received from the client selected for use, and Menchik's cited disclosures are directed to controller-computed parameters and controller-provided control capability—not client-selected operational parameters transmitted back to the printer after providing tag data to a client. (EX1009 ¶¶[0024], [0027], [0047]–[0048]). As I previously noted, a POSITA would understand that the controller would not send anything (e.g., print files, operational parameters) to itself over a network.

158. In my opinion, for instance, Menchik discloses a separate device—"a computing platform connected to 3D printer system 100"—as providing a printing file which the system then uses to determine "the order and configuration of deposition of building material." EX1009, ¶[0025]. This separate device in Menchik is not the controller. Thus, the printing file is not sent or received from a

client as Petitioner has identified it (i.e., controller 105), but rather a separate device that Petitioner does not identify as the client.

159. In my opinion, Petitioner references printing parameters on page 61 of the Petition, but that portion of the Petition only says that “printing parameters” are “compute[d].” Pet. at 61. There is no teaching or disclosure that any “printing parameters” are received from a client (which, as discussed Petitioner has erroneously mapped to Menchik’s controller 105). Indeed, Menchik does not describe that the computed printing parameters, such as “guidelines for which cartridges to use, how many to use, if and when any replacements are necessary etc.,” are received from the controller 105. EX1009, ¶[0037].

160. Besides a conclusory assertion, Petitioner never references operation parameters or building parameters in its argument for claim element 1[f] or claim element 1[b], which is referenced in the argument for claim element 1[f]. Menchik only uses each of the terms “operation parameters” and “building parameters” once to describe the information stored on the memory chip. *See* EX1009, ¶[0035] (“optimal operation parameters” and “optimum building parameters”). However, Menchik does not teach or disclose receiving any of the parameters from the controller 105. Rather, Menchik discloses the opposite—that the parameters are stored on the memory chip 260, which is read by reader 225, which sends data to the controller. EX1009 at ¶[0037].

161. Although Petitioner references material parameters on page 61 of the Petition and Menchik discloses “material parameters,” the reference merely describes computing “material parameters” and not receiving such parameters from the controller. See EX1009 at ¶[0027] (“controller 105 may use software code 120 to process data related to the status of building material in one or more supply sources to compute material parameters for building material(s)” and “For example, material parameters may indicate potential yields during printing usage etc. For example, computations of material required may indicate how much material from one or more material supply sources may be used in constructing one or more objects.”).

162. In my opinion, similarly, there is no teaching or disclosure of receiving the supply parameters from the controller. See Pet. at 61-62. Menchik merely describes determining the supply parameters and then controlling system components or sending messages to a system operator to alert the operator to replace a cartridge. See EX1009, ¶¶[0027], [0051] (“the controller may provide instructions to close a valve of an empty cartridge, or a cartridge or source”), [0053] (“controller 105 may, for example, transmit an alert message to one or more system operators”); see also *id.* at Fig. 6 and ¶¶[0007] (“control the supply of the building material from two or more cartridges according to the supply parameters”), [0027], [0049].

163. In my opinion, thus, even if Petitioner were to articulate its theories, as it was required to do, identifying which pieces of information are allegedly received and why such information are operational parameters (it has failed to satisfy its burden), there is no teaching or disclosure in Menchik that such information (printing file, printing parameters, operation parameters, building parameters, material parameters, and supply parameters) are received from a client.

D. Ground 3A Does Not Render Claim 19 Unpatentable

164. As I discuss below, Petitioner fails to show that Menchik discloses or teaches each of the elements of claim 19 and thus the reference does not anticipate or render obvious the claim.

1. Petitioner failed to appropriately address element 19[e]

165. I understand that in its institution decision, the Board recognized that Petitioner contends element 19[e] is taught “based on the analysis of ‘element 1[f] and claim 10,’” and the Board reproduced a side-by-side comparison showing that element 19[e] includes requirements, including that the operational parameter is determined “based upon at least on[e] property of the build material,” that are not found in element 1[f] or dependent claim 10. (Inst. Dec. at 35–36; Pet. at 71).

2. Petitioner still bears the burden on the merits, and its “supra element 1[f] and claim 10” cross-reference does not prove element 19[e]

166. Claim 19 requires “determining an operational parameter for configuring the three-dimensional printer for a fabrication process using the build

material based upon at least one property of the build material in the data,” and requires that the operational parameter include at least one of the enumerated items (including, e.g., “a support structure requirement”). (EX1001 at claim 19). Petitioner, however, did not provide a Menchik-specific mapping for element 19[e], instead asserting only: “Supra, element 1[f] and claim 10.” (Pet. at 71). Petitioner’s expert likewise provided no element-19[e]-specific analysis, opining only that “Menchik anticipates element 19[e] for the same or substantially the same reasons that I discussed above with respect to element 1[f] and claim 10.” (EX1003 ¶154).

167. I understand that the Board’s own comparison confirms why Petitioner’s cross-reference fails: element 19[e] requires determining an operational parameter based upon at least one property of the build material in the data and requires the parameter include at least one of the specific enumerated requirements, whereas element 1[f] is directed to receiving operational parameters “from the client,” and claim 10 is directed to a different subset that includes, for example, “extruder temperature” and “feed rate,” which are not among claim 19[e]’s enumerated requirements. (Inst. Dec. at 35–36; EX1001 at Claims 10, 19).

3. Menchik’s cited disclosures do not satisfy element 19[e]’s “determining ... based upon at least one property ... in the data” requirement

168. In my opinion, Petitioner’s Ground 3A claim 1 discussion relies on Menchik’s disclosure that cartridge memory may store information such as “optimal operation parameters (e.g., recommended jetting temperature)” and “optimum building parameters (e.g., for building or support),” along with “material parameters (e.g., viscosity and surface tension at the recommended temperature).” (Pet. at 59–60; EX1009 ¶[0035]). However, element 19[e] requires that the operational parameter be determined “based upon at least one property of the build material in the data,” not merely that some information may be stored on a cartridge memory or otherwise exist in the system. (EX1001 at claim 8; Inst. Dec. at 36). Petitioner’s element-19[e] showing never identifies what Menchik allegedly “determines” as the operational parameter for configuring the printer, nor does it identify what “at least one property” in the tag data is supposedly used as the basis for such determination. (Pet. at 71; EX1003 ¶154).

4. Menchik’s disclosures also do not establish that the “determined” parameter includes at least one of claim 19[e]’s enumerated requirements, including a “support structure requirement”

169. Claim 19[e] further requires that the determined operational parameter include at least one of: “a build platform temperature, a build volume temperature, an infill requirement, a rafting requirement, a support structure requirement, and a

cooling requirement.” (EX1001 at claim 19). A POSITA would understand that the operational parameters in claim 19 are all parameters specifically relating to fused filament fabrication (FFF) processes. By contrast, the process described in Menchik is an inkjet 3D printing process in which droplets of liquid ink are jetted. EX1009, ¶[0004]. The operational parameters of claim 19 (e.g., “an infill requirement,” “a rafting requirement,” “a support structure requirement”) relate to an entirely different 3D printing process, FFF, which is fundamentally different from inkjet printing. As such, a POSITA reading Menchik would not understand that reference to disclose or teach any of the claimed operational parameters of claim 19.

170. In my opinion, to the extent Petitioner’s theory gestures at “support” by pointing to Menchik’s statement that the controller may compute “the amount of modeling material, support liquid, or combination of modeling and supporting materials required for printing a given three-dimensional object,” that passage is about estimating material quantities for a job, not about a printer-configuration “support structure requirement” of the type enumerated in claim 19[e]. (EX1009 ¶[0048]). Even for that “support liquid/support materials required” computation, Petitioner did not explain (or cite evidence) how the computed amount constitutes a “support structure requirement” and how it is “based upon at least one property of the build material in the data,” as claim 19[e] requires. (Pet. at 67–71; EX1001

at claim 19). In fact, I understand that the Board recently addressed a similar argument raised by Petitioner in denying institution in IPR2025-00585 (the related '464 Patent). There, the Board found that “[t]he record before us therefore lacks any teaching or suggestion that ‘the amount of modeling material, support liquid, or combination of modeling and support materials required for printing a given three-dimensional object’ (which Petitioner contends are operational parameters) are determined ‘based upon the data [that includes at least one property of the building material].’” IPR2025-00585, Paper 11 at 29-30 (P.T.A.B. Oct. 6, 2025). Claim 19 contains the same requirement here: “determining an operational parameter for configuring the three-dimensional printer for a fabrication process using the build material based upon at least one property of the build material in the data...”. EX1001 at claim 19. In short, there is no teaching or disclosure of why the amount of support liquid or support materials required is a support structure requirement, and there is no teaching or disclosure of the amount of support liquid and support materials required being based upon at least one property of the build material in the data.

171. In my opinion, Petitioner’s Petition and expert declaration never show an operational parameter in Menchik that (i) is determined based upon at least one property in the tag data and (ii) includes at least one of claim 19[e]’s enumerated

requirements. For each of these reasons, Petitioner has failed to show that Menchik anticipates or renders obvious claim 19.

E. Ground 3A Does Not Render Dependent Claims 3–5, 7, 9–11, and 20 Unpatentable

172. Dependent claims 3-5, 7, 9-11, and 20 all depend from claim 1, and therefore Ground 3A does not render those dependent claims unpatentable for the reasons discussed above. For the additional reasons discussed below, Ground 3A further fails to teach or suggest the additional limitations of dependent claims 3-5 and 10.

1. Claim 3-5

173. Claim 3 further requires “wherein the three-dimensional printer is coupled to a first supply of a first build material and a second supply of a second build material different from the first build material, the first supply including a first tag that stores at least one property of the first build material, and the second supply including a second tag that stores at least one property of the second build material.” EX1001, 23:53-59. Claims 4 and 5 (through claim 4) depend from claim 3.

174. In my opinion, Petitioner’s treatment of claim 3 consists solely of the conclusory statement: “Supra, element 1[a],” with a single citation to Dr. Hickner. (Pet. at 64; EX1003 ¶139). Dr. Hickner likewise does not analyze claim 3’s additional requirements regarding two supplies of different build materials and two

corresponding tags; instead, he cites only Menchik's generic disclosure that the printing apparatus "may include" "one or more three-dimensional modeling material supply sources such as cartridge apparatuses 180 or cartridge arrays 190." (EX1003 ¶139; EX1009 ¶[0020]).

175. Menchik's cited paragraph does not disclose that the three-dimensional printer is coupled to both (i) a first supply of a first build material including a first tag storing at least one property of the first build material and (ii) a second supply of a second build material different from the first build material including a second tag storing at least one property of the second build material, as claim 3 requires. (EX1001 at claim 3; EX1009 ¶[0020]). Instead, the only Menchik disclosure Petitioner invokes for claim 3 merely states that the system may include "one or more" supply sources "such as" cartridge apparatuses or cartridge arrays, which does not identify (or even address) claim 3's requirement of two different build-material supplies each having its own tag storing at least one property of that supply's build material. (EX1009 ¶[0020]). Because Petitioner provides no element-by-element showing for claim 3 beyond this incorporation-by-reference and a conclusory expert citation, Petitioner has not met its burden to explain—with record support—where Menchik teaches the specific additional limitations of claim 3 (first/second supplies; different build materials; first/second tags storing at least

one property of each build material). (Pet. at 64; EX1003 ¶139). Claims 4 and 5 are patentable for at least the same reasons.

2. Claim 10

176. Claim 10 further requires “wherein the one or more operational parameters includes at least one of an extruder temperature, a feed rate, a build platform temperature, a build volume temperature, an infill requirement, a rafting requirement, a support structure requirement, and a cooling requirement.” EX1001, 24:21-26. Claim 10 depends from claim 1 and therefore incorporates claim 1’s requirements (including receiving “one or more operational parameters from the client” in element 1[f]). (EX1001 at claim 1).

a) Petitioner’s claim-10 theory equates Menchik’s “recommended jetting temperature” with “an extruder temperature” and relies on Menchik’s “optimum building parameters” and “amount of support liquid ... required” as a “support structure requirement”

177. I understand that Petitioner asserts that “[b]ased on Menchik’s disclosure as discussed above in 1[f], the recommended jetting temperature is an extruder temperature,” and that “the optimum building parameters (e.g., for building or support) and the amount of support liquid and support materials required is a support structure requirement.” (Pet. at 67–68; EX1009 ¶[0035]). Dr. Hickner repeats this same theory, opining that “the recommended jetting temperature is an extruder temperature,” and that “the optimum building

parameters (e.g., for building or support) and the amount of support liquid and support materials required is a support structure requirement.” (EX1003 ¶146).

b) Petitioner’s theory fails because Menchik’s “recommended jetting temperature” is not “an extruder temperature,” and Petitioner supplies no record basis for treating it as one

178. Claim 10 expressly recites “an extruder temperature” as one of the enumerated operational-parameter types, which is different on its face from a “jetting temperature.” (EX1001 at claim 10). Menchik’s disclosure Petitioner relies upon is expressly a “recommended jetting temperature,” not an “extruder temperature.” (EX1009 ¶[0035]; Pet. at 67). The process described in Menchik is an inkjet 3D printing process in which droplets of liquid ink are jetted. The “recommended jetting temperature” is specific to this inkjet process. The “extrusion temperature” of claim 10 instead refers to an entirely different 3D printing process known as fused filament fabrication (FFF). FFF is fundamentally different from inkjet printing, and it fabricates parts by melting/softening plastic in a nozzle and continuously extruding it from a moving nozzle in order to “draw” the desired shape. Petitioner’s statement that “recommended jetting temperature is an extruder temperature” is erroneous. Petitioner simply asserts that “recommended jetting temperature is an extruder temperature” without identifying any disclosure in Menchik describing an “extruder,” describing an “extruder temperature,” or

equating “jetting” temperature to “extruder” temperature in the manner claim 10 requires. (Pet. at 67–68; EX1009 ¶[0035]; EX1003 ¶146).

c) Petitioner’s claim-10 mapping also fails because claim 10 requires the printer to receive the operational parameters from the client, while Petitioner relies on parameters stored on cartridge memory and computed by the controller

179. In my opinion, Petitioner’s claim-10 theory relies on information stored on cartridge memory (including “recommended jetting temperature” and “optimum building parameters”) and on controller computations of material quantities (including the “amount of ... support liquid ... required”), which are not described as operational parameters received from the client as claim 1[f] requires. (Pet. at 61–62 (element 1[f]), 67–68; EX1009 ¶¶[0035]). Dr. Hickner likewise bases his claim-10 opinion on Menchik disclosures regarding stored cartridge data and controller computations, not on any disclosure that the printer receives a client-selected “extruder temperature” (or any other claim-10 enumerated parameter) from a client. (EX1003 ¶¶133–135, 146; EX1009 ¶¶[0035], [0048]). As I previously explained, a POSITA would understand that the controller would not send anything (e.g., print files, operational parameters) to itself over a network.

d) Petitioner’s reliance on “amount of support liquid ... required” does not establish claim 10’s recited “support structure requirement,” and in any event is not shown to be a client-provided operational parameter

180. I understand that Petitioner attempts to satisfy the “support structure requirement” by citing Menchik’s disclosure that the controller may compute “the amount of ... support liquid ... required,” but that disclosure addresses a quantity computation for a given object, not a printer-configuration “support structure requirement” of the type recited in claim 10. (Pet. at 68; EX1009 ¶[0048]; EX1001 at Claim 10). Petitioner does not explain—nor does it cite evidence showing—how a computed “amount of support liquid ... required” constitutes a “support structure requirement” as an operational parameter, rather than a consumption estimate or planning metric. (Pet. at 67–68; EX1003 ¶146; EX1009 ¶[0048]). Even if Menchik’s computed “amount of support liquid ... required” could be characterized as support-related information, Petitioner still does not show it is an operational parameter received from the client as required by claim 10 through claim 1[f]. (EX1001 at claims 1, 10; Pet. at 61–62 (element 1[f]); Pet. at 68; EX1009 ¶[0048]).

e) Conclusion

181. In my opinion, Petitioner’s claim-10 theory rests on an unsupported equivalence between “recommended jetting temperature” and “an extruder temperature,” and on a further conflation of a controller-computed “amount of

support liquid ... required” with claim 10’s “support structure requirement.” (Pet. at 67–68; EX1009 ¶¶[0035], [0048]; EX1003 ¶146). Because claim 10 depends from claim 1 and thus requires receiving operational parameters “from the client,” and because Petitioner relies instead on cartridge-stored data and controller computations rather than client-provided operational parameters of the enumerated claim-10 types, Petitioner has not met its burden to prove claim 10 unpatentable under Ground 3A.

XI. GROUND 3B: CLAIMS 1, 3-5, 7, 9-11, AND 20 WOULD NOT HAVE BEEN OBVIOUS OVER MENCHIK (EX1009) AND JAZAYERI (EX1010)

182. I understand that in Ground 3B of the Petition, Petitioner asserts that claims 1, 3-5, 7, 9-11, and 20 are obvious over Menchik (EX1009) and Jazayeri (EX1010). I have reviewed Petitioner’s challenges in Ground 3B, and it is my opinion that Ground 3B fails to teach or suggest all elements of claims 1, 3-5, 7, 9-11, and 20. I explain my opinions below in detail.

183. Ground 3B proposes the combination of *Menchik* and *Jazayeri*. See Pet. 1. As explained above, *Jazayeri* is not a proper reference for an obviousness challenge. *Supra* § VIII.B. A POSITA would likewise not be motivated to combine *Jazayeri* (directed to 2D printing) with *Menchick* (directed to 3D printing) for the reasons previously discussed for Ground 1B. *Supra* § VIII.C. Further, Petitioner does not separately address claim element 1[e] and 1[f] in Ground 3B (*Menchik* and *Jazayeri*) and thus Ground 3B does not teach claim elements 1[e] and 1[f] for

at least the same reasons as provided above for Ground 3A. *See* (Pet. at 71); *supra* §§ X.B.2, X.B.3.

A. Ground 3B Does Not Render Independent Claim 1 Unpatentable

184. Claim 1 expressly requires “receiving a request from a client over a network to fabricate an object on the three-dimensional printer.” (EX1001 at claim 1).

185. In my opinion, Petitioner’s Ground 3B theory is expressly conditional—“[t]o the extent that Menchik’s printing file ... is not considered a request,” Petitioner relies on “the additional disclosure of Jazayeri” to supply element 1[b] by importing Jazayeri’s “print server” / “application manager” workflow that receives a “print request over a network,” provides a print dialog to select a printer, and then receives a “print job” including “print data” and “print characteristics.” (Pet. at 71; EX1010 at Abstract), ¶¶[0008]–[0010], [0019]–[0021], [0036]; EX1003 ¶¶156–158). However, Jazayeri’s “print request” and “print job” are directed to conventional document-printing constructs—print data and print characteristics such as paper size, orientation, and number of copies—rather than three-dimensional fabrication of an object. (EX1010, ¶¶[0019]–[0021], [0036]). Additionally, Petitioner’s mapping relies on Jazayeri’s disclosure that the “print request” is received by an application manager in a “print server,” not by the three-dimensional printer, and Petitioner therefore satisfies element 1[b] only by an

architecture-level redesign rather than any teaching that the printer receives the claimed fabrication request over the network. (Pet. at 71–74; EX1010 at Abstract, ¶¶0036]; EX1003 ¶¶156–162). Accordingly, in my opinion, Petitioner has not met its burden to show claim 1 unpatentable under Ground 3B.

B. Ground 3B Does Not Render Dependent Claims 3–5, 7, 9–11, 20 Unpatentable

186. I understand that Petitioner states that, other than claim element 1[b], “the analysis of all other claim elements is identical” to Ground 3A. (Pet. at 71). Accordingly, Ground 3B does not render Dependent Claims 3-5, 7, 9-11, and 20 unpatentable for the reasons discussed previously for Ground 3A. *Supra X*.

XII. GROUNDS 3C/3D: CLAIMS 2, 8, 12, AND 16 WOULD NOT HAVE BEEN OBVIOUS OVER GROUND 3C OR GROUND 3D

187. Dependent claims 2, 8, 12, and 16 all depend from claim 1, and therefore Grounds 3C/3D do not render those dependent claims unpatentable for the reasons discussed above for Grounds 3A/3B. *Supra X-XI*.

XIII. GROUNDS 1E/1F/3E/3F: CLAIM 17 WOULD NOT HAVE BEEN OBVIOUS OVER GROUNDS 1E/1F/3E/3F

188. I understand that in Grounds 1E/1F/3E/3F of the Petition, Petitioner asserts that claim 17 is obvious over Loughran, Dubois, Menchik, and Dahlin (Ground 1E); Loughran, Dubois, Jazayeri, Menchik, and Dahlin (Ground 1F); Menchik and Dahlin (Ground 3E); and Menchik, Jazayeri, and Dahlin (Ground 3F). I have reviewed Petitioner’s challenges in Grounds 1E/1F/3E/3F, and it is my

opinion that Grounds 1E/1F/3E/3F fail to teach or suggest all elements of claim 17.

I explain my opinions below in detail.

189. Dependent claim 17 depends from claim 1, and therefore Grounds 1E/1F/3E/3F do not render those dependent claims unpatentable for the reasons discussed above for Grounds 1A/1B/3A/3B. *Supra* VII-VIII, X-XI. Grounds 1E/1F/3E/3F further fail to teach or suggest the additional limitation of claim 17.

A. Claim 17

190. Claim 17 further requires “performing a diagnostic test to determine whether the one or more operational parameters is suitable for the three-dimensional printer.” EX1001, 24:47-50. Claim 17 is dependent on claim 1, which defines the relevant “operational parameters” as parameters that are “receiv[ed] ... from the client,” are “selected for use in controlling operation of the three-dimensional printer,” and are used “when fabricating the object with the build material.” (EX1001 at claim 1). The ’466 Patent explains that “the determination of operational parameters may include preliminary diagnostic tests” directed to whether build-material characteristics (e.g., “diameter,” “size of a build material pellet,” or “fluid viscosity”) are “appropriate for the three-dimensional printer.” (EX1001 at 15:52–57). Petitioner advances the same claim-17 mapping in Grounds 1E/1F and 3E/3F: it relies on Menchik (and, as needed, Dahlin) to supply claim 17’s “diagnostic test” and “operational parameter” limitations—with Ground 3

asserting Menchik/Dahlin alone disclose those limitations, and Ground 1 asserting the same Menchik/Dahlin theory as an add-on to Petitioner's broader multi-reference combination.

a) Petitioner's claim-17 theory across Grounds 1E/1F/3E/3F hinges on recharacterizing a material-sufficiency computation as both the claimed "operational parameter" and the claimed "diagnostic test"

191. In my opinion, Petitioner's Ground 1E/1F/3E/3F claim 17 theory is that Menchik's controller computes the "amount of modeling material, support liquid, or combination of modeling and support materials required for printing a given three-dimensional object," and then determines "whether the amount of modeling and/or support material in the available cartridges is sufficient to complete a three-dimensional object." (Pet. at 39–40, 78-80; EX1009 ¶¶[0048]–[0049]). Petitioner then asserts that the computed "amount ... required" is itself "an operational parameter," and that "calculating whether a cartridge contains enough material to complete the print job" is "a diagnostic test to determine whether the operational parameter (the amount of material required) is suitable for the printing apparatus to complete the print job." (Pet. at 40–41, 78-79; EX1003 ¶174). Petitioner further contends that, "[t]o the extent that Menchik were considered to not disclose a diagnostic test that provides an error message when the amount of support material is insufficient," a POSITA would have found it "obvious and straightforward" to

implement Menchik to provide such an error message. (Pet. at 40, 78-79; EX1003 ¶172).

192. As purported evidence of such a “diagnostic” notification concept, Petitioner cites Dahlin’s disclosure that a CPU “calculate[s] whether a spool ... contains enough filament to complete the job” and then provides operator notification stating either that filament is adequate or that a spool “will need replacement and reloading during the process.” (Pet. at 40, 79; EX1011 at 5:26–37). Petitioner also relies on Dahlin’s disclosure that the CPU uses “support filament data” to provide operator information “in the same manner” as for modeling filament. (Pet. at 40; EX1011 at 5:55–64).

b) Petitioner’s theory fails because “amount of material required” is not the claim-17 “operational parameters” whose “suitability” is tested

193. Claim 17’s “diagnostic test” is expressly tied to whether “the one or more operational parameters” are “suitable for the three-dimensional printer,” and claim 1 makes those “operational parameters” the parameters the client selects and sends for controlling printer operation during fabrication. (EX1001 at claims 1, 17). Petitioner’s identification of “the amount of material required” as the relevant “operational parameter” is thus a categorical mismatch with claim 1’s client-selected, printer-operation-controlling “operational parameters.” (*Id.*). An “amount of material required” is a consumables-quantity estimate used for supply

management; it does not “control[] operation of the three-dimensional printer” during fabrication, and therefore cannot be the claim-1 “operational parameter” whose “suitab[ility]” claim 17 requires the diagnostic test to assess.

194. The intrinsic record reinforces that mismatch by describing “operational parameters” as printer-configuration settings (e.g., “extruder temperature,” “feed rate,” “build platform temperature,” “infill requirement,” “rafting requirement,” “support structure requirement,” and “cooling requirement”), not a computed consumables-quantity estimate. (EX1001 at 15:17–24). Likewise, the patent’s description of “diagnostic tests” focuses on whether build-material characteristics are “appropriate for the three-dimensional printer,” not whether a cartridge/spool has enough material remaining to finish a particular job. (EX1001 at 15:52–57). Based on my review, Menchik’s cited disclosures describe a supply-management sufficiency check (required quantity vs. available quantity), not a diagnostic test of whether an operational parameter is “suitable for the three-dimensional printer” as claim 17 requires. (EX1009 ¶¶[0048]–[0049]; EX1001 at claim 17).

195. I understand that the Board recently addressed materially similar “diagnostic test” language in denying institution in IPR2025-00585 (the related ’464 Patent). The Board recognized that “the plain language of [the] claim ... requires two distinctive steps: determining an operational parameter ... followed

by performing a diagnostic test,” and—under its “best understanding”—assumed the diagnostic test is distinct from the operational-parameter determination. IPR2025-00585, Paper 11 at 15-18 (P.T.A.B. Oct. 6, 2025).. That reasoning is inconsistent with Petitioner’s attempt here to satisfy claim 17 by relabeling a material-sufficiency computation as both the claimed “operational parameter” and the claimed “diagnostic test.”

c) Dahlin does not cure the defect because Dahlin likewise discloses only a filament-sufficiency check and operator notification—not a diagnostic test of claim-1 “operational parameters”

196. Dahlin’s cited disclosure is that “at the outset of a job” the CPU “will calculate whether a spool ... contains enough filament to complete the job,” and then notify the operator that filament is adequate or that a spool will require replacement/reloading. (EX1011 at 5:26–37). That Dahlin calculation is expressly driven by “amount of filament on the spool” data and whether it is “insufficient to create a desired object,” i.e., an inventory sufficiency determination rather than a test of operational-parameter suitability. (EX1011 at 1:64–2:2, 5:26–37). Dahlin’s “support filament” disclosure likewise concerns using support-filament data to provide operator information “in the same manner” as modeling filament, again reflecting a consumables/inventory check and notification paradigm rather than a suitability test of printer-operating parameters. (EX1011 at 5:55–64).

197. In my opinion, accordingly, even accepting Petitioner’s premise that Menchik and/or Dahlin disclose ways to warn an operator about insufficient material, those disclosures still do not teach claim 17’s requirement of performing a diagnostic test of whether the claim-1 “operational parameters” (client-selected parameters for controlling printer operation) are suitable for the three-dimensional printer.

d) Conclusion

198. In my opinion, Because Petitioner’s Grounds 1E/1F/3E/3F satisfy claim 17 only by redefining a supply-quantity requirement (“amount of material required”) as the claim’s “operational parameters,” and by further treating a material-inventory sufficiency check as the required “diagnostic test,” Petitioner fails to show that claim 17 is taught or rendered obvious under Grounds 1E/1F/3E/3F.

XIV. GROUNDS 1C/1D/3G/3H: CLAIM 5 WOULD NOT HAVE BEEN OBVIOUS OVER GROUNDS 1C/1D/3G/3H

199. I understand that in Grounds 1C/1D/3G/3H of the Petition, Petitioner asserts that claim 5 is obvious over Loughran, Dubois, and KISSlicer (Ground 1C); Loughran, Dubois, Jazayeri, and KISSlicer (Ground 1D); Menchik and KISSlicer (Ground 3G); and Menchik, Jazayeri, and KISSlicer (Ground 3H). I have reviewed Petitioner’s challenges in Grounds 1C/1D/3G/3H, and it is my opinion that

Grounds 1C/1D/3G/3H fail to teach or suggest all elements of claim 5. I explain my opinions below in detail.

200. Dependent claim 5 depends from claim 1, and therefore Grounds 1C/1D/3G/3H do not render those dependent claims unpatentable for the reasons discussed above for Grounds 1A/1B/3A/3B. *Supra* VII-VIII, X-XI. Grounds 1C/1D/3G/3H further fail to teach or suggest the additional limitation of claim 5.

A. Overview of KISSlicer (EX1018)

201. I have reviewed KISSlicer (EX1018), which is a short “Quick-Start Guide” for creating a “first print file.” EX1018. KISSlicer includes guidance on downloading/running the software and configuring settings used to generate (slice) a toolpath for printing. EX1018. The guide explains that users first set printer, material, and print-style settings in preferences/advanced settings. EX1018. It describes configurable style and material parameters (e.g., profiles for print styles; material profiles such as ABS/PLA; fan behavior; temperature; min/max speeds; “destring” settings; and flow-rate adjustments). EX1018.

B. Claim 5

202. Claim 5 further requires “receiving a selection of one of the first build material and the second build material from the client for use in fabricating the object using the three-dimensional printer.” EX1001, 23:64-67. Claim 5 depends from claim 4, which requires “providing data from the first tag and the second tag

to the client over the network,” reinforcing that the claimed selection is made in (and transmitted back within) the same networked client/printer workflow involving tag data for two different supplies. (EX1001 at claims 4-5).

1. Petitioner’s Ground 1C/1D theory (Loughran + Dubois + KISSlicer, and Loughran + Dubois + Jazayeri + KISSlicer) does not teach “receiving a selection ... from the client” as claim 5 requires

203. I understand that Petitioner relies on Loughran’s disclosure that an “inkjet SFF system” may use “a jet for each of a plastic build material and a wax-like support material.” (Pet. at 36-37; EX1004 ¶¶0016]; EX1003 ¶101). Petitioner then asserts that a POSITA would have found it obvious to implement the Loughran/Dubois system (or Loughran/Dubois/Jazayeri) “to allow the user of the client system to select the plastic build material” for one jet and “to select the support material” for another jet, purportedly “based on KISSlicer’s suggestions.” (Pet. at 37–39; EX1003 ¶101; EX1018 at 1–11). However, that theory does not identify any disclosure in Loughran, Dubois, Jazayeri, or KISSlicer where the three-dimensional printer actually receives from a client a selection of one of two tagged build materials for use in fabricating the object, as claim 5 requires.

204. The statement that “[a] POSITA would have found it obvious... to allow the user of the client system to select the plastic build material to be extruded by one jet for printing the three-dimensional object and to select the support material extruded by another jet for printing the support structure” (Pet. at 36-37;

EX1004 ¶[0016]; EX1003 ¶101) erroneously conflates two different 3D printing processes. As previously described, the term “extrusion” in this sentence would be known to a POSITA to refer to the fused filament fabrication (FFF) process, whereas the term “jet” would be known to refer to inkjet 3D printing. Those are two very different 3D printing processes, and “material to be extruded by one jet” represents an infeasible combination.

205. The KISSlicer software specifically prepares 3D printer build jobs for extrusion-based FFF printers, and not inkjet 3D printing processes. KISSlicer’s described “select” and “assign” functions are presented as slicer settings used to prepare print files and assign extruders to part/raft/support behaviors, not as a claimed step in which the printer receives a client-provided selection between two tagged build materials in response to tag data provided “over the network.” (EX1018 at 1–3, 5, 11). In other words, KISSlicer is a slicing-software guide that describes configuring “printer, material and print style” settings and selecting/assigning materials and extruders within the slicer workflow, not transmitting a material-selection message that the printer “receiv[es] ... from the client” in the claim-required networked tag-data exchange. (EX1018 at 1–3, 5, 11; EX1001 at claims 4–5). Slicer software can “assign” different extruders/materials within a print file, but in my opinion that offline assignment does not disclose the claimed workflow where tag data for multiple supplies is provided to a client and

a selection between tagged supplies is returned to the printer over a network. In fact, Dr. Hickner admitted during his deposition that KISSlicer provides default materials and allows manual parameter updates (e.g., temperature), but it does not ingest tag data from a material supply. (EX2015, 108:11–22; 108:12 – 110:18). Dr. Hickner further admitted, when speaking about his own experiences, that “in general . . . within [a] slicer program . . . there’s information about the build material in that slicer program. And that’s transmitted over the network to the printer,” and that “it’s entirely possible to transmit material – or, sorry, transmit a data about a build material over a network in the absence of that tag.” (EX2015, 25:17–26:11). Thus, even if KISSlicer were considered, it would not provide the claimed tag to client to selection workflow.

206. Jazayeri (added in Grounds 1D/3H) likewise concerns a print-server “print request” and “print job” framework for printing “print data” with “print characteristics,” not client selection between two tagged build materials for 3D fabrication. (EX1010 at ¶[0036]).

2. Petitioner’s Ground 3G/3H theory (Menchik + KISSlicer, and Menchik + Jazayeri + KISSlicer) fails for the same reasons

207. For Grounds 3G/3H, Petitioner relies on Menchik’s statement that “the supply of building materials of multiple colors or types required for the printing of a given object may be . . . selectively controlled.” (Pet. at 80–81; EX1009 ¶[0018]; EX1003 ¶[177]). Petitioner then asserts a POSITA would have found it obvious to

implement Menchik (or Menchik as modified by Jazayeri) “to allow the user of the client system to select the plastic build material” for one printing head and “to select the support material” for another printing head, again “based on KISSlicer’s suggestions” discussed for Grounds 1C/1D. (Pet. at 80–82; EX1003 ¶177; EX1018 at 1–11). However, Petitioner again does not identify any disclosure in Menchik, KISSlicer, or Jazayeri where the printer *receives* “a selection of one of the first build material and the second build material from the client” as claim 5 requires, as opposed to (at most) controller-side or software-profile configuration of materials/heads. *See supra* § XIV.B.1. Furthermore, as discussed above for Grounds 1C/1D, Menchik, like Loughran, relates to inkjet printing, whereas KISSlicer relates to fused filament fabrication printing. *See supra* § XIV.B.1. Accordingly, Petitioner has not met its burden to prove claim 5 unpatentable under Grounds 1C/1D/3G/3H.

XV. CONCLUSION

208. For the reasons set forth above, it is my opinion that claims 1-5, 7-13, and 16-20 of the 10,568,466 Patent would not have been obvious to a person of ordinary skill in the art at the relevant time.

209. In signing this Declaration, I understand it will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I understand I may be subject to cross-examination in this

case, and that any cross-examination will take place in the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

210. I declare that all statements made herein of my knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001.

211. I declare under penalty of perjury under the laws of the United States that the forgoing is true and correct.

Executed on this 16th day of January, 2026.

Denis Cormier

Dr. Denis R. Cormier

APPENDIX A

Denis R. Cormier

Curriculum Vitae

Earl. W. Brinkman Professor
AMPrint Center Director
Rochester Institute of Technology
Department of Industrial and System Engineering
Phone: (585) 475 - 2713
Fax: (585) 475 - 2520
E-mail: drceie@rit.edu
Citizenship: U.S.

Areas of Specialization

- 29 years of experience with additive manufacturing and 3D printing processes
- Computer Aided Design and Manufacturing (CAD/CAM)
- Electromechanical Systems Integration

Education

- B.S., Systems Engineering, 1989, University of Pennsylvania, Philadelphia
- M.S. Industrial Engineering, 1991, State University of New York at Buffalo
- Ph.D. Industrial Engineering, 1995, North Carolina State University

Professional Experience

- 2011-present Professor, Industrial Engineering Dept., RIT
- 2014 – present Program Faculty Member, Materials Science & Engineering, RIT
- 2010-present Core Faculty, Microsystems Engineering, RIT
- 2009 – 2011 Associate Professor, Industrial Engineering Dept., RIT
- 2005 – 2009 Affiliate Faculty, Biomedical Engineering, NC State University
- 2002 – 2006 Director, Furniture Mfg. and Management Center, NC State University
- 2001 – 2009 Associate Professor, Industrial Engineering Dept., NC State University
- 1995 - 2001 Assistant Professor, Industrial Engineering Dept., NC State University
- 1994 - 1995 Visiting Researcher, Industrial Engineering Dept., NC State University

Professional Awards and Honors

- 2024 Solid Freeform Fabrication FAME career achievement award for contributions to additive manufacturing and 3D printing R&D
- 2023 Fellow of the Institute of Industrial and Systems Engineers (IISE)
- 2022 Fulbright Specialist
- 2020 Smart Manufacturing Magazine's 20 Most Influential Faculty in Smart Manufacturing
- 2018 IISE Manufacturing and Design Outstanding Service Award

- Editorial Advisory Board - Additive Manufacturing Journal
- Editorial Advisory Board - Rapid Prototyping Journal
- 2014-2015 Chairman of SME's Rapid Technologies and Additive Manufacturing (RTAM) technical community
- Outstanding Young Manufacturing Engineer Award, Society of Manufacturing Engineers, 2003

Issued Patents

- Cormier, D., Badesha, S., and Sambhy, V. "Metal Drop Ejecting Three-Dimensional (3D) Object Printer Having An Increased Material Deposition Rate", US Patent 12370604B2, issued 07/29/2025.
- Mantell, D., Chungbin, C., Cormier, D., Cormier, D., Meda, M., and Jayabal, D. "Method and System for Operating a Metal Drop Ejecting Three-Dimensional (3D) Object Printer To Form Electrical Circuits On Substrates", US Patent US12186992B2, issued 01/07/25.
- Cormier, D., Badesha, S., and Sambhy, V. "Metal Drop Ejecting Three-Dimensional (3D) Object Printer Having An Increased Material Deposition Rate", US Patent US 11,904,388 B2, issued 02/20/24.
- Cormier, D., Badesha, S., and Sambhy, V. "Metal Drop Ejecting Three-Dimensional (3D) Object Printer Having An Increased Material Deposition Rate", European Patent EU4023369C0, issued 04/24/24.
- Cormier, D., Badesha, S., and Sambhy, V. "Metal Drop Ejecting Three-Dimensional Object Printer" US Patent No. US 11,737,216 B2, issued 08/22/23.
- Mantell, D., Chungbin, C., Cormier, D., Cormier, D., and Jayabal, D. "Method and System for Operating a Metal Drop Ejecting Three-Dimensional (3D) Object Printer To Form Electrical Circuits On Substrates", US Patent US 11,731,366 B2, issued 08/22/23.
- Mantell, D., Chungbin, C., Liu, C.H., Vader, S., Vader, Z., Sukhotskiy, V., Cormier, D., and Tawil, K. "Method and System for Operating a Metal Drop Ejecting Three-Dimensional (3D) Object Printing to Compensate for Geometric Variations During An Additive Manufacturing Process", US Patent No. US 11565475 B2, issued 01/31/23.
- Mahajan, C., Cormier, D., Irving, M., Williams, S., Borkholder, D., and Alfadhel, A. "Magnetic Field Patterning of Electrically Anisotropic Nickel Nanofibers Using Precursor Ink", US Patent No. US 11254156 B2 issued 02/22/2022.
- Borkholder, D., Forouzandeh, F., Carter, R., Cormier, D., Walton, J., Frisina, R. "Peristaltic Micropumps and Fluid Delivery Devices That Incorporate Them", US Patent No. US 11,020,524 B1 issued 6/1/21.
- Cormier, D., Taylor, J., and West, H. "Methods and Apparatus for Rapidly Prototyping Three-Dimensional Objects from a Plurality of Layers", US Patent US-6324438-B1, issued 11/27/01.

Pending Patent Applications

- Borkholder, D., Ouyang, J., Cormier, D., and Alfadhel, A. "Pulse Energy Manipulation of Material Properties", US Patent Application US-2023-0276709-A1, filed 05/08/23.

- Cormier, D., Poddar, P., Tarr, X., Kon, J., and Foster, A. "Extrusion System for Additive Manufacturing", US Patent Application US-2023-0173751-A1, filed 11/03/21.
- Cormier, D., Badesha, S., and Sambhy, V. "Building An Object With A Three-Dimensional Printer Using Vibrational Energy", US Patent Application US-2022-0219381 A1, filed 12/31/20.
- Cormier, D., Badesha, S., and Sambhy, V. "Method and System for Operating a Metal Drop Ejecting Three-Dimensional (3) Object Printer to Form Vias In Printed Circuit Boards With Conductive Metal", US Patent Application US-2022/0240387 A1, filed 01/22/21.
- Cormier, D., Jayabal, D., Cormier, D., Badesha, S., and Sambhy, V. "Fabrication of Lattice Structures With A Three-Dimensional Printer", US Patent Application US-2022-0212249, filed 12/31/20.
- Cormier, D., Rifat, U., and Mehta, P. "Building An Object With A Three-Dimensional Printer Using Burst Mode Jetting", US Patent Application US-2022-0184708, filed 12/15/20.

Relevant Patent Law Consulting

- Served as an expert witness on behalf of Markforged in its 2018-2019 Desktop Metal V. Markforged patent infringement and patent invalidity case. Was involved in all aspects of the case through and including the jury trial.

Research Funding

Career funding as the principal investigator for additive manufacturing and 3D printing research exceeds \$30M. A full listing of research grants/contracts is available upon request.

- Government research sponsors include the Department of Energy, the Air Force Research Labs, the Office of Naval Research, the National Science Foundation, the National Institutes of Health, the U.S. Army Materiel Command, and NASA.
- Industry research sponsors include Boeing, Lockheed Martin, Northrop Grumman, Xerox, Corning, Intel, General Electric, and many others.

Publications

Books

- Walsh, R., and Cormier, D. (2005) *Machining and Metalworking Handbook 3rd Edition*, McGraw-Hill, NY.

Book Chapters

- Cormier, D. and Poddar, P. (2020) "Durability of Additively Manufactured Composite Systems", Chapter 7 in *Durability of Composite Systems*, K. Reifsnider (editor), Elsevier.
- Parekh, D., Cormier, D., and Dickey, M. (2015) "Multi-functional Printing: Incorporating Electronics into 3-D Parts Made by Additive Manufacturing", *Additive Manufacturing*, Amit Bandyopadhyay (editor), CRC Press.

- Khatri-Chhetri, P., Datar, A., and Cormier, D. (2012) "Novel SOFC Processing Techniques Employing Printed Materials." *Advances in Materials Science for Environmental and Energy Technologies: Ceramic Transactions* 236 (2012): 129.
- Harrysson, O., and Cormier, D. (2006) "Direct Fabrication of Custom Orthopedic Implants Using Electron Beam Melting Technology", in *The Use of Advanced Manufacturing Technology for Medical Applications*, I. Gibson (editor), John Wiley & Sons, West Sussex, UK.
- Cormier, D., Young, R., and Bartlett, W. (2002) "Evaluation of Rapid Prototyping and Tooling Technologies," in *Economic Evaluation of Advanced Technologies: Techniques and Case Studies*, J. Lavelle, H. Liggett, and H. Parsaei (editors), Taylor & Francis, New York, NY, pp. 35 - 50.
- Weintraub, A., Zozom, A., Cormier, D., and Hodgson, (2001) T. "Evaluating Alternative Process Plans In Large Manufacturing Systems" in *Computer-aided Process and Assembly Planning*, J. Usher (editor), Gordon and Breach, Chapter 12.
- Cormier, D., and O'Grady, P. (1997) "A Constraint-Based Genetic Algorithm for Concurrent Engineering", in *Manufacturing Decision Support Systems*, Hamid Parsaei (editor), Chapman and Hall, pp. 256-281.

Journal Articles

- Myers, Jade; Phillips, Daniel; Cormier, Denis., (2025) "Assessing 3D printable density-graded lattice structures to minimize risk of tissue damage from compression-release stabilized sockets" *Prosthetics and Orthotics International*, 49(1):p 76-82, DOI: 10.1097/PXR.0000000000000406.
- Assad, A., Bevans, B.D., Potter, W., Rao, P., Cormier, D., Deschamps, F., Hamilton, J.D. and Rivero, I.V., 2024. Process mapping and anomaly detection in laser wire directed energy deposition additive manufacturing using in-situ imaging and process-aware machine learning. *Materials & Design*, p.113281, <https://doi.org/10.1016/j.matdes.2024.113281>.
- Lee, S., Lin, H., Kahn, B.E., Malakhov, A., Kovach, B., Tran, Q.T., Ghosh, S., Liu, P., Cormier, D. and Minh, N.Q., (2023). Development of Novel 3D Cell Structure and Manufacturing Processes for Highly Efficient, Durable, and Redox Resistant Solid Oxide Electrolysis Cells. *ECS Transactions*, 111(6), p.825, DOI 10.1149/11106.0825ecst.
- Hamilton, J., Trauernicht, D., Cormier, D., and Rivero, I. (2023) "Laser-based Directed Energy Deposition Remanufacturing of Gray Cast Iron using Stainless Steel 316L and Inconel 625 Filler Materials", *Advanced Engineering Materials*, 25(24), <https://doi.org/10.1002/adem.202301212>.
- Liu, Li; Xu, Zhiheng; Molina Vargas, Adrian Moises; Dollery, Steve ; Schrlau, Michael; Cormier, Denis (D.); O'Connell, Mitchell; Tobin, Gregory; Du, Ke, (2023) "Aerosol Jet Printing Enabled Dual-Function Electrochemical and Colorimetric Biosensor for SARS-CoV-2 Detection", *Analytical Chemistry*, 95(22) pp 11997-12005, <https://doi.org/10.1021/acs.analchem.3c01724>.
- Ramesh, S., Xu, Z., Rivero, I.V. and Cormier, D.R., (2023). Computational fluid dynamics and experimental validation of aerosol jet printing with multi-stage flow focusing lenses. *Journal of Manufacturing Processes*, 95, pp.312-329, <https://doi.org/10.1016/j.jmapro.2023.03.035>.
- Liu, L., Xu, Z., Awayda, K., Dollery, S.J., Bao, M., Fan, J., Cormier, D., O'Connell, M., Tobin, G.J. and Du, K., (2022) "Gold Nanoparticle-Labeled CRISPR-Cas13a Assay for the Sensitive Solid-State Nanopore Molecular Counting" *Advanced Materials Technologies*, p.2101550.

- Hamilton, J., Sorondo, S., Greeley, A., Zhang, X., Cormier, D., Li, B., Qin, H., and Rivero, I. (2022) "Property-Structure-Process Relationships In Dissimilar Material Repair with Directed Energy Deposition: Repairing Gray Cast Iron using Stainless Steel 316L, *Journal of Manufacturing Processes*, 81, pp. 27-34, <https://doi.org/10.1016/j.jmapro.2022.06.015>.
- Ramesh, S., Mahajan, C., Gerdes, S., Gaikwad, A., Rao, P., Cormier, D., and Rivero, I. (2022) "Numerical and Experimental Investigation of Aerosol Jet Printing" *Additive Manufacturing*, 59, p. 103090.
- Poddar, P., Olles, M., and Cormier, D. (2022) "Mechanical Response of Carbon Composite Octet Truss Structures Produced Via Axial Lattice Extrusion ", *Polymers*, 14(17), p. 3553.
- Meda, M., Mehta, P., Mahajan, C., Kahn, B., and Cormier, D. (2021) "Magnetohydrodynamic liquid metal droplet jetting of highly conductive electronic traces" *Flexible and Printed Electronics*, 6(3), p. 035002.
- Meda, M., Sukhotskiy, V., and Cormier, D. (2021) "Pinhole formation in printed electronic traces fabricated via molten metal droplet jetting" *Electronics*, 10, 1568. <https://doi.org/10.3390/electronics10131568>.
- Srikanthan Ramesh, Yunbo Zhang, Denis R. Cormier, Iris V. Rivero, Ola L.A. Harrysson, Prahalad K. Rao, Ali Tamayol, (2021) Extrusion bioprinting: Recent progress, challenges, and future opportunities, *Bioprinting*, <https://doi.org/10.1016/j.bprint.2020.e00116>.
- Ge, C., Cormier, D. and Rice, B., (2020). "Damping and cushioning characteristics of Polyjet 3D printed photopolymer with Kelvin model" *Journal of Cellular Plastics*, p.0021955X20944972.
- Mahajan, C., Marotta, A., Kahn, B., Irving, M., Gupta, S., Hailstone, R., Williams, S., and Cormier, D. (2019) "Formation of copper nickel bimetallic nanoalloy film using precursor inks", *Materials Sciences and Applications*, 10(4), pp 349-363, DOI:[10.4236/msa.2019.104026](https://doi.org/10.4236/msa.2019.104026).
- Mahajan, C., Alfadhel, A., Irving, M., Kahn, B., Borkholder, D., Williams, S., Cormier, D. (2019) "Magnetic Field Patterning of Nickel Nanofibers Using Nickel Precursor Ink", *Materials*, 12, 928, DOI:[10.3390/ma12060928](https://doi.org/10.3390/ma12060928).
- Ouyang, J., Cormier, D., Borkholder, D., (2019) "Piezoelectric property enhancement of PZT thick film via pulsed flash poling during sintering" *ACS Applied Energy Materials*, 2(1), pp. 338 – 343.
- Forouzandeh F., Zhu X., Alfadhel A., Ding B., Walton J.P., Cormier D., Frisina R.D., Borkholder D.A., (2019) "A nanoliter resolution implantable micropump for murine inner ear drug delivery" *Journal of Controlled Release*, 298, pp. 27 – 37.
- Zope, K., Cormier, D., and Williams, S. (2018) "Reactive Silver Oxalate Ink Composition with Enhanced Curing Conditions for Flexible Substrates", *ACS Applied Materials & Interfaces*, 10(4), pp. 3830-3837.
- Alfadhel, A., Ouyang, J., Mahajan, C., Cormier, D., and Borkholder, D. (2018) "Inkjet Printed Polyethylene Glycol as a Fugitive Ink for the Fabrication of Flexible Microfluidic Systems" *Journal of Materials and Design*, V150, pp. 182-187.
- Mudgal, T., Bhadrachalam, K., Bischoff, P., Cormier, D., Manley, P., and Hirschman, K. (2017) "CMOS Thin-Film Transistors via Xe Flash-Lamp Crystallization of Patterned Amorphous Si" *ECS Journal of Solid State Science and Technology*, 6(12), pp. Q179-Q181.

- Priyadarshini, L., Pan, L., Tuber, J., Cormier, D., and Ge, G. (2017) "A Preliminary Study of Cushion Properties of a 3D Printed Thermoplastic Polyurethane Kelvin Foam", *Packaging Technology and Science*, DOI: 10.1002/pts.2330, pp. 1-8.
- Fan, R., Piou, M., Darling, E., Cormier, D., Sun, J., & Wan, J. (2016). Bio-printing cell-laden Matrigel-agarose constructs. *Journal of Biomaterials Applications*, 0885328216669238.
- Wadwa, A., Cormier, D., and Williams, S. (2016) Improving run-time stability with aerosol jet printing using a solvent add-back bubbler" *Journal of Print and Media Technology Research*, V5 N3, pp. 207-214. DOI: 10.14622/JPMTR-1610
- J. Ouyang, D. Cormier, S. A. Williams, and D. A. Borkholder, (2016) "Photonic Sintering of Aerosol Jet Printed Lead Zirconate Titanate (PZT) Thick Film Transducers" *Journal of the American Ceramics Society*, 99(8), pp. 2569-2577.
- Yang, L., Harrysson, O., West, H., and Cormier, D. (2015) "Mechanical Properties of 3D Re-Entrant Honeycomb Auxetic Structures Realized Via Additive Manufacturing", *International Journal of Solids and Structures*, V69, pp. 475-490.
- Das, S., Cormier, D., and Williams, S. (2015) "Potential for Multi-Functional Additive Manufacturing Using Pulsed Photonic Sintering", *Procedia Manufacturing*, V1, pp. 366-377.
- Yang, L. Harrysson, O., Park, C., West, H., Cormier, D., and Peters, K. (2015) "Low-energy drop weight performance of cellular sandwich panels", *Rapid Prototyping Journal*, 21(4), pp. 433-442, <http://dx.doi.org/10.1108/RPJ-08-2013-0083>.
- Yang, L., Harrysson, O., Cormier, D., West, H., Gong, H., and Stucker, B. (2015) "Additive Manufacturing of Metal Cellular Structures: Design and Fabrication" *Journal of Materials*, 67(3), DOI: <http://dx.doi.org/10.1007/s11837-015-1322-y>.
- West, H., Harrysson, O., Horn, T., Cormier, D., Aman, R. and Marcellin-Little, D. (2015) "Novel Materials and Structures Fabricated by Electron Beam Melting" *Microscopy and Microanalysis*, 21(S3), pp.461-462.
- Mugdal, T., Reepmeyer, C., Manley, R., Cormier, D., and Hirschman, K. "Crystallization of Amorphous Silicon and Dopant Activation Using Xenon Flash-Lamp Annealing (FLA)", *MRS Proceedings*, 1666, pp. 91-96.
- Yang, L. Harrysson, O., West, H., and Cormier, D., (2013) "A Comparison of Bending Properties for Cellular Core Sandwich Panels", *Materials Sciences and Applications*, V4, pp. 471-477, DOI:10.4236/msa.2013.48057.
- Kumar, V., Cormier, D., and Harrysson, O. (2012) "Electrical Conductivity of Hexagonal Periodic Lattice Structures", *Virtual & Physical Prototyping*, 7(1), pp. 81-90.
- Srisawadi, S., Cormier, D., Harrysson, O., and Modak, S. (2012) "Computational Design of Electrode Networks for Preferentially Aligned Short Fiber Composite Component Fabrication via Dielectrophoresis", *International Journal of CAD/CAM*, 12(1).
- Yang, L. Harrysson, O., West, H., and Cormier, D., (2012) "Modeling of uniaxial compression in a 3D periodic re-entrant lattice structure", *Journal of Materials Science*, DOI: 10.1007/s10853-012-6892-2.

- Yang, L., Cormier, D., West, H., Harrysson, O., and Knowlson, K. (2012) "Non-Stochastic Ti-6Al-4V Foam Structures With Negative Poisson's Ratio", *Materials Science and Engineering A*, pp. 579-585, <http://dx.doi.org/10.1016/j.msea.2012.08.053>.
- Yang, L. Harrysson, O., West, H., and Cormier, D., (2012) "Compressive properties of Ti-6Al-4V auxetic mesh structures made by Electron Beam Melting", *Acta Materialia*, V60, pp. 3370-3379. <http://dx.doi.org/10.1016/j.actamat.2012.03.015>
- Purser, M., Richards, A., Cook, R., Osborne, J., Cormier, D., and Buckner, G., (2011) "A Novel Shape Memory Alloy Annuloplasty Ring for Minimally Invasive Surgery: Design, Fabrication and Evaluation", *Annals of Biomedical Engineering*, 39(1), pp. 367-377.
- Jernigan, S., Chanoit, G., Veeramani, A., Owen, B., Hilliard, M., Cormier, D., Laffitte, B., and Buckner, G. (2010) "A Laparoscopic Knot-Tying Device for Minimally Invasive Cardiac Surgery", *European Journal of Cardio-thoracic Surgery*, 37(3), pp. 626 - 630.
- Purser, M., Richards, A., Cook, R., Osborne, J., Cormier, D., and Buckner, G. (2009) "Evaluation of a Shape Memory Alloy Reinforced Annuloplasty Band for Robot-Assisted Mitral Valve Repair", *Annals of Thoracic Surgery*, 88(4), pp. 1312-1316.
- Cansizoglu, O., Harrysson, O., West, H., Cormier, D., and Mahale, T. (2008) "Applications of Structural Optimization in Direct Metal Fabrication", *Rapid Prototyping Journal*, 14(2), pp. 114-122.
- Harrysson, O, Cansizoglu, O., Marcellin-Little, D., Cormier, D., and West, H. (2008) "Direct Metal Fabrication of Titanium Implant Components With Tailored Materials and Mechanical Properties Using Electron Beam Melting Technology", *Materials Science & Engineering C*, 28(3), pp. 366-373.
- Cansizoglu, O., Harrysson, O., Cormier, D., West, H., and Mahale, T.(2008) "Properties of Ti-6Al-4V Non-stochastic Lattice Structures Fabricated Via Electron Beam Melting", *Materials Science & Engineering A*, 492(1-2), pp. 468-474.
- Cormier, D., Harrysson, O., Mahale, T., and West, H. (2007) "Freeform Fabrication of Titanium Aluminide via Electron Beam Melting Using Prealloyed and Blended Powders," *Research Letters in Materials Science*, vol. 2007, Article ID 34737, 4 pages, 2007. doi:10.1155/2007/34737
- Jernigan, S.R., Buckner, G.D., Eischen, J.W., and Cormier, D.R. (2007) "Finite Element Modeling of the Left Atrium to Facilitate the Design of an Endoscopic Atrial Retractor", *ASME Journal of Biomechanical Engineering*, V129, pp. 825-837.
- Aman, R., West, H., and Cormier, D. (2007) "An Evaluation of Loose Tenon Joint Strength In Furniture Applications", *Forest Products Journal*, 58(3), pp. 61-64.
- Cormier, D., Harrysson, O., and West, H. (2004) "Characterization of High Alloy Steel Produced Via Electron Beam Melting", *Rapid Prototyping Journal*, 10(1), pp. 35 - 41.
- Cormier, D., Harrysson, O., and Mahale, T. (2003) "Rapid Manufacturing in the 21st Century", *Journal of the Chinese Institute of Industrial Engineers*, 20(3), pp. 193 - 201.
- Harrysson, O., Cormier, D., Marcellin-Little, D., and Jajal, K. (2003) "Rapid Prototyping for Treatment of Canine Limb Deformities", *Rapid Prototyping Journal*, 9 (1), pp. 37 – 42.

- Zozom, A.J. Jr., T.J. Hodgson, R.E. King, A.J. Weintraub, and D. Cormier, (2003) "Integrated Job Release and Shop Floor Scheduling to Minimize WIP and Meet Due-Dates," *International Journal of Production Research*, 41(1), pp. 31 - 45.
- Cormier, D., Taylor, J. and West, H. (2002) "An Investigation of Selective Coloring With 3-D Laser Printing", *Journal of Manufacturing Processes*, 4(2), pp. 148 - 152.
- Cormier, D. and Taylor, J. (2001) "A Process for Solvent Welded Prototype Tooling", *Robotics and Computer-Integrated Manufacturing*, 17(1/2), pp. 151 – 157.
- Taylor, J., Cormier, D., Joshi, S., and Venkataraman, V. (2001) "Contoured Edge Slice Generation in Rapid Prototyping Via 5-axis Machining" *Robotics and Computer-Integrated Manufacturing*, 17(1/2), pp. 13 - 18.
- Cormier, D., Unnanon, K., and Sanii, E. (2000) "Specifying Non-Uniform Cusp Heights As A Potential Aid for Adaptive Slicing", *Rapid Prototyping Journal*, 6(3), pp. 204 - 211.
- Cormier, D. and Unnanon, K. (2000) "Virtual Interference Checking of Furniture Assemblies", *Forest Products Journal*, 50(5), pp. 1-5.
- Zozom, A., Weintraub, A., Cormier, D., and Hodgson, T. (2000) "Implementation of a Virtual Factory Cell Scheduling System" *Engineering Valuation and Cost Analysis*, Vol. 2, pp. 395 - 407.
- Weintraub, A., Cormier, D., Hodgson, T., King, R., Wilson, J., and Zozom, A. (1999) "Scheduling With Alternatives: A Link Between Process Planning and Scheduling" *IIE Transactions*, Vol 31, pp. 1093 – 1102.
- Hodgson, T., Cormier, D., Weintraub, A., and Zozom, A. (1998) "Note. Satisfying Due Dates in Large Job Shops" *Management Science* 44(10), pp. 1442 - 1446.
- Cormier, D., and O'Grady, P., (1998) "Survival of the Fittest Designs: Using Evolution In Concurrent Engineering" *International Journal of Production Research*, 36(6), pp 1679 – 1697.
- Weintraub, A., and Cormier, D., (1997) "A Testbed for Scheduling with Alternative Process Plans," *International Journal of Intelligent Automation and Soft Computing*, 3, No. 3, pp. 231 - 238.
- Kim, K., Cormier, D., O'Grady, P., and Young, R. (1995) "A System for Design and Concurrent Engineering Under Imprecision," *Journal of Intelligent Manufacturing*, 6, pps. 11 - 27.

Selected Conference Papers (Representative Listing)

- Chibuikem Iheonu, Jade Myers, Denis Cormier, Patricia Iglesias "Additive Manufacturing of Textured Polymer Surfaces for Potential Friction and Wear Reduction in Hip Replacements: A Preliminary Study", Proceedings of the ASME 2025 International Mechanical Engineering Congress and Exposition IMECE2025 November 16-19, 2025, Memphis, TN
- Marin-Montealegre, V., Mehta, P., Rochani, A. and Cormier, D., 2025. Porous zinc structures using molten metal jetting additive manufacturing. *Transactions on Additive Manufacturing Meets Medicine*, 7(S1), pp.2246-2246.
- Williams, S.A., Jones, K.E, and Cormier, D.R. (2024) "Shaping the Future of Glass: 3D Printing of with Optimized Sol-gel Inks for Complex and Functional Structures" NRO First Conference, Chantilly, VA, Aug. 21, 2024.

- Myers, J., Phillips, D., Cormier, D. (2023). Using 3D Printable Density-Graded Lattice Structures to Minimize Risk of Tissue Damage from Compression-Release Stabilized Sockets. *ISPO 19th World Congress, Guadalajara, Mexico, April 24-27.*
- Munagauuru, D. and Cormier, D. (2022) "3D Printed Continuous Fiber Composites With Woven Structures" Proceedings of the 2022 Institute of Industrial Engineering Annual Research Conference, May 21-24, Seattle WA. Finalist for Best M&D Paper Award.
- Cormier, D., Liu, R., Iglesias Victoria, P., Zhang, S., and Greeley, A. (2022) "Effect of Inherently Porous Structure Produced By Metal Fused Filament Fabrication On the Tribological Behavior of Lubricated Steel-Steel Contact" *2022 International Manufacturing Science and Engineering Conference.*
- Greeley, A., and Cormier, D. (2021) "Vibration-Actuated Powder Dispensing for Directed Energy Deposition Systems", *Proceedings of the 2021 Solid Freeform Fabrication Symposium.*
- Alfadhel, A., Ouyang, J., Cormier, D., and Borkholder, D., (2020) "Enhanced properties of Aerosol Jet Printed PZT: Towards Realizing Flexible Automotive Sensors" IEEE Sensors Conference.
- Hamilton, J.D., Sorondo, S., Greeley, A., Kahn, B.E., Cyr, P., Cormier, D., Rivero, Iris V., 2019, October, "Hybrid Manufacturing: Influence of Directed Energy Deposition Parameters on Microstructure and Layer Adhesion of Stainless Steel 316L," Heat Treat 2019: Proceedings of the 30th ASM Heat Treating Society Conference, Detroit, Michigan.
- Jayabal, D., Zope, K., and Cormier, D. (2018) "Fabrication of Support-Less Engineered Lattice Structures Via Jetting of Molten Aluminum Droplets", *Solid Freeform Fabrication 2018 Proceedings*, Aug. 15th, 2018, Austin TX, pp. 757-764.
- Forouzandeh, F., Alfadhel, A., Xhu, X., Walton, J.P., Cormier, D., Frisina, R., and Borkholder, D. (2018) "A Wirelessly Controlled Fully Implantable Microsystem for Nano-Liter Resolution Inner Ear Drug Delivery" *2018 Solid-State, Actuators, and Microsystems Workshop*, May 2018.
- Ge, C., Cormier, D., and Rice, B. (2018) "Damping and Cushioning Characteristics of a Polyjet 3D Printed Photopolymer Kelvin Foam", *21st IAPRI World Conference On Packaging.*
- Poddar, P., and Cormier, D. (2017) "Engineered Lattice Structures With Axially Aligned Fibers", *International Conference on Computational & Experimental Engineering Science*, June 28th, 2017.
- Ouyang, J., Mahajan, C., Alfadhel, A., Cormier, D., and Borkholder, D., (2017) "Inkjet-printed Polyethylene-glycol sacrificial layer for Flexible Microfluidic Electronics", submitted to *Transducers 2017 Conference Proceedings.*
- Ooi, Y.K., Ugras, C., Gandhi, S., Cormier, D., and Zhang, J. (2017) "Integration of 3D printed dome-shaped lens with InGaN light-emitting diodes with enhanced light extraction efficiency" *SPIE Photonics West Conference Proceedings*, San Francisco, CA.
- Yang, L., Harrysson, O., Cormier, D., West, H., Zhang, X., Gong, H., and Stucker, B. 2016 "Design for Additively Manufactured Lightweight Structures: A Perspective", *Solid Freeform Fabrication 2016 Proceedings*, pp. 2165-2180.
- Cormier, D. (2016) "Frontiers and Challenges In Additive Manufacturing" *DURACOSYS 2016 Conference Proceedings*, Arlington, TX, June 13-15.
- Poddar, P., Williams, S., and Cormier, D. (2016) "Reduction of Coffee-Ring Defects in Inkjet Printed Electronics via High Speed Drying" *Proceedings of the 2016 Industrial and Systems Engineering Research Conference*, IIE, Anaheim, CA.

- Yang, L., Harrysson, O., Cormier, D., and West, H. (2015) "Shear Properties of Re-Entrant Auxetic Cellular Structures Made Via Electron Beam Melting" Solid Freeform Fabrication Symposium Proceedings, pp. 1394-1410.
- Mahajan, C., and Cormier, D. (2015) "3D Printing of Carbon Fiber Composites With Preferentially Aligned Fibers", *Proceedings of the 2015 Industrial and Systems Engineering Research Conference*, IIE, Nashville, TN. *Paper received ISERC Best Student Paper award.
- Ouyang, J., Penmetcha, A.R., Cormier, D. and Borkholder, D.A., 2015, November. Photonically Sintered PZT Energy Harvester. In *ASME 2015 International Mechanical Engineering Congress and Exposition* (pp. V010T13A024-V010T13A024). American Society of Mechanical Engineers.
- T. Mudgal, C. Reepmeyer, R.G. Manley, D. Cormier, and K.D. Hirschman (2014) "Crystallization of Amorphous Silicon and Dopant Activation using Xenon Flash-Lamp Annealing (FLA)" MRS Proceedings, Volume 1666, DOI: <http://dx.doi.org/10.1557/opl.2014.722>.
- Yang, L., Harrysson, O., Cormier, D., West, H., Park, C., and Peters, K. "Design of Auxetic Sandwich Panels for Structural Applications", 2013 Solid Freeform Fabrication Symposium Proceedings, Aug. 12-14, Austin, TX.
- Folgar, C., Folgar, L., and Cormier, D. "Multifunctional Material Direct Printing for Laser Sintering Systems", 2013 Solid Freeform Fabrication Symposium Proceedings, Aug. 12-14, Austin, TX.
- Ninkov, Z., Robinson, R., Bhaskaran, S., Arp, U., and Cormier, D. "Quantum Dot Coating of COTS CMOS Detector Arrays to Enhance UV and X-ray Sensitivity", 2013 SPIE Conference Proceedings.
- Khatri-Chhetri, P., Cormier, D., Chen, F., and Majumdar, P. (2011) "Printed Fuel Cell Electrodes With Engineered Porosity" NIP 27 and Digital Fabrication 2011 Proceedings. pp. 645.
- Johnson, D.G., Getpreecharsawas, J., Balasubramanian, S., Datar, A., Cormier, D., and Borkholder, D.A. (2011) "Hybrid MEMS: Extending Micro Manufacturing With Direct Write Processes" *Technologies for Future Micro/Nano Manufacturing Workshop - Technical Digest*, Aug. 8-10, Napa CA.
- Yang, L., Harrysson, O., West, H., and Cormier, D. (2011) "Design and characterization of orthotropic re-entrant auxetic structures made via EBM using Ti6Al4V and pure copper", *Proceedings of the 2011 Solid Freeform Fabrication Symposium*, Austin TX, Aug. 8-10 2011.
- Yang, L., Harrysson, O., West, H., and Cormier, D. (2011) "Characterization of Ti6Al4V 3D Auxetic Structures Fabricated via the Electron Beam Melting Process", *Proceedings of the 2011 Materials Science & Technology Conference*, Columbus OH, Oct. 17-19.
- Kumar, V., Manogharan, G., and Cormier, D. (2009) "Design of Periodic Cellular Structures for Heat Exchanger Applications" Proceedings of the 2009 Solid Freeform Fabrication Symposium, Austin, TX, August 3-5.
- Frigola, P., Agustsson, R., Boucher, S., Murokh, A., Badakov, H., Musumeci, P., Rosenzweig, J. Travish, G., Faillace, L., Cormier, D., and Mahale, T. (2009) "Development of Solid Freeform Fabrication (SFF) for the Production of RF Photoinjectors" Proceedings of the 12th European Particle Accelerator Conference.
- Frigola, P., Agustsson, R., Boucher, S., Murokh, A., Rosenzweig, J. Travish, G., Faillace, L., Cormier, D., and Mahale, T. (2008) "A Novel Fabrication Technique for the Production of RF

Photoinjectors” Proceedings of the 11th European Particle Accelerator Conference, Genoa, Italy, June 23-27.

- Mahale, T., Cormier, D., Harrysson, O., and Ervin, K. (2007) “Advances in Electron Beam Melting of Aluminum Alloys” Proceedings of the 2007 Solid Freeform Fabrication Symposium, Austin, TX, August 6-8.
- Cansizoglu, O., Harrysson, O., West, H., Mahale, T., Cormier, D. (2007) Direct Metal Fabrication of Geometrical Models Designed Using Optimization Techniques for Medical and Structural Applications, ICMA Proceedings 2007, May 28-30, Singapore.
- Harrysson, O. Deaton, B. Bardin, J., West, H., Cansizoglu, O., Cormier, D., and Marcellin-Little, D. (2006) “Evaluation of Titanium Implant Components Directly Fabricated Through Electron Beam Melting Technology”, Materials & Processes for Medical Devices, Boston, MA, November 14-16, 2005.
- Cormier, D., West, H., Harrysson, O. and Knowlson, K. (2004), “Characterization of thin walled Ti-6Al-4V components produced via electron beam melting”, *Solid freeform fabrication symposium* (pp. 440-447).
- Cormier, D., Harrysson, O., Low, J., and Knowlson, K. (2004) "Optimization of the Electron Beam Melting Process", Proceedings of the 11th Industrial Engineering Research Conference, Houston, Texas, May 16 – 18, 2004.
- Cormier, D., Harrysson, O. "Contoured Machining of Orthopedic Surfaces for Biomedical Implants” Proceedings of the 11th Industrial Engineering Research Conference, Portland, OR, May 18 – 21, 2003.
- Harrysson, O.L., Cormier, D.R. and Jajal, K., 2003, January. Custom Design and Manufacturing of Canine Knee Implant. In *IIE Annual Conference. Proceedings* (p. 1). Institute of Industrial Engineers-Publisher.
- Harrysson, O. L. A., D. R. Cormier, D. J. Marcellin-Little, and K. R. Jajal. (2003) "Direct fabrication of metal orthopedic implants using electron beam melting technology." In *Solid Freeform Fabrication Symposium Proceedings*, pp. 439-446. 2003.
- Cormier, D. and Harrysson, O., 2002, January. Mass Customization Via Rapid Manufacturing. In *IIE Annual Conference. Proceedings* (p. 1). Institute of Industrial Engineers-Publisher.
- Cormier, D., Taylor, J., Unnanon, K., Kulkarni, P. and West, H., 2000, August. Experiments in layered electro-photographic printing. In *Proceedings of the SFF Symposium* (pp. 267-274).
- Mahale, T.R., Taylor, J.B. and Cormier, D.R., 2000. Five axis freeform fabrication of the thermoplastic parts via SWIFT. In *Proceedings of the SFF Symposium* (pp. 289-297).
- Weintraub, A.J., Zozom Jr, A., Hodgson, T.J. and Cormier, D., 1997, December. A simulation-based finite capacity scheduling system. In *Proceedings of the 29th conference on Winter simulation* (pp. 838-844). IEEE Computer Society.

Graduate Student Advising

The following sections list only those graduate students whose committees I have either chaired or co-chaired. It does not include service as M.S. and Ph.D. committee member (too many to list).

PhD Students Chaired or Co-Chaired

Student	Topic	Status
Valeria Marin-Montealegre	Metal Jetting of Bioresorbable Zinc Alloys	In-Progress
Irtaza Razvi	Multi-Nozzle Liquid Metal Droplet Jetting	In-Progress
Sai Sri Nidhi Munaganuru	3D Printed Carbon Fiber Composites	In-progress
Usama Rifat	Magneto Jet Printed 4008 Aluminum	In-progress
Khushbu Zope	Multi-Scale Modeling of Molten Metal Droplet Jetting	In-progress
Paarth Mehta	Metal Additive Manufacturing Using Magneto-hydrodynamic Liquid Metal Jetting	In-progress
Gabriel Stash	Molten Metal Melt Shaping	In-progress
Kareem Tawil	Computation Fluid Dynamics of Molten Metal Droplet Jetting	In-progress
Saidur Roney	Progressive Cavity Dispensing of Molten Metals	In-progress
Andrew Greeley	Powder Feed Efficiency In Hybrid Metal Additive Manufacturing	2023
Pritam Poddar	3D Printed Carbon Fiber Composite Axial Lattice Structures	2022
Manoj Meda	Printed Electronics Via Magneto-hydrodynamic Liquid Metal Jetting	2021
Chaitanya Mahajan	Reactive Metal Alloy 3D Printing	2019
Ronald Aman	Bioresorbable Magnesium Alloy Bone Implants	2013
Li Yang ¹	Design and Analysis of Auxetic Cellular Materials	2012
Sasitorn Srisawadi	Freeform Fabrication of Composite Lattices	2011
Molly Purser	Annuloplasty Ring with Integrated Shape Memory Alloy Frame	2009
Tushar Mahale	Electron Beam Melting Material Development	2009
Ade Febranyah	Integration of Process Planning and Scheduling	2001
Kittinan Unnanon	Adaptive Slicing of Rapid Prototyping Models	2000
Alexander Weintraub ²	Scheduling With Alternatives In A Resource Constrained Environment	1998

Master's Students Chaired or Co-Chaired

Student	Topic	Status
Amelia Cardinali	An Exploration of 3D Multi-Material 3D Printing With Rigid and Compliant Polymers	2024
Chris Ventre	Design of a Rod Feeding Mechanism for Molten Metal Droplet Jetting	2024
David Olney	Automated Analysis of Engineered Lattice Structures in nTop Software	2023
Hope Scott	Development of an In-Situ Metal Droplet Jet Stability Monitoring System	2023
Bobby Kovach	Fabrication of a Novel Solid Oxide Electrolyzer Support Layer Structure Via Nanoparticle Inkjet Printing	2023
Usama Rifat	Magneto Jet Printing of 4008 aluminum	2023

Evan Cole	Strength Properties of Recycled and Virgin PEEK in Additive Manufactured Carbon Fiber Composite Parts	2022
Koral Fries	Mechanical Properties of 3D Printed Engineered Lattice Structures	2022
Ajinkya Patil	5-Axis Fused Filament Fabrication	2022
Alex Kibbe	Hybrid Additive/Subtractive Manufacturing Process Planning	Spring 2021
Anubhav Mukherjee	Preferential Alignment of Carbon Fibers in Wire Frame Structures using Fused Filament Fabrication and effects of conditioning on CF - Nylon composite	2020
Steve Sutton	Laser Powder Bed Fusion of a Custom Invar Alloy (MS Project)	2020
Dan Martin	Exploration of Generative Design for a Bicycle Frame	2020
Abishek Shankar	Metal Fused Filament Fabrication Study	2020
Sara Hernandez	KNN-Based Energy Harvesting	2019
Paritosh Mhatre	Multi-Nozzle 3D Printing With A Rotary Axis	2019
Dinesh Jayabal	Engineered Lattice Structures Printed Via Magnetohydrodynamic Liquid Metal Jetting	2019
Manoj Meda	Reactive Copper Ink Formulation and Curing for Printed Electronics	2019
Anthony Tantillo	Fused Filament Extrusion In A Nitrogen Atmosphere	2019
Shaunak Gandhi	3D Printed Optics	2018
Smruti Sahoo	3D Printed Electronic Device Interfaces	2017
Dhananjay Dubey	Pulsed Photonic Curing of Silicone Rubber	2017
Kshitij Luthria	A Study of 3D Printed Assembly Clearances	2016
Sourav Das	Influence of Slope and Distance In Photonic Curing of Conformally Printed Electronics	2015
Pritam Poddar	Pulsed Photonic Curing of Screen Printed Copper Oxide	2015
Akanksha Umrani	Fabrication of Micro Pillar Arrays Via Aerosol Jet Printing	2015
Matthew Jackson	Infrared Drying Parameter Optimization	2015
Arjun Wadhwa	Run-time Ink Stability in Pneumatic Aerosol Jet Printing using a Split Stream Solvent Add Back System	2014
Chaitanya Mahajan	3D Microextrusion of Aligned Carbon Fiber Composite Materials	2014
Swaroop Yerassi	Electro-Spinning of Ceramic Nano-Fibers	2014
Omkar Rishi	Feedrate Effects In Freeform Filament Extrusion	2014
Anuj Datar	A Microextrusion Process Parameter Model	2012
Sundareshan Balasubramanian	Thin film aerosol jet deposition of Cerium Oxide Nanoink	2012
Niranjana Damle	Controlled Porosity in SOFC Cathodes Produced Via Aerosol Jet Printing	2012
Tejas Bendarkar	Multi-material pneumatic microdispensing	2012
Prasanna Khatri Chhetri	Functionally Graded Electrodes In Solid Oxide Fuel Cells	2011
Lionel Senyana	An Evaluation of Electron Beam Melting As An Alternative To Forging	2011
Guha Manogharan	Analysis of Non-Stochastic Lattice Structure Design for Heat Exchanger Applications	2009

Vikas Kumar	Freeform Fabrication of Advanced Heat Exchanger Geometries	2009
Abhishek Kapur	Microwave Sintering of SOFC Materials	2008
Sayantan Modak	Freeform Fiber Alignment Via Dielectrophoresis	2008
Sasitorn Srisawadi	Rapid Tooling for Electrochemical Machining	2006
Ada Villalon	Improving the Surface Finish of Electron Beam Melted Components	2005
Ketan Jajal	Design of Custom Canine Knee Implant	2003
Tushar Mahale	Three-Dimensional Laser Printing	2003
Pradeep Mahadeven	3-D Laser Printing Process Optimization	2003
Parikshit Kulkarni	CAD-Based Training of a Robot Vision System	2001
Akhil Oltikar	Computer-Aided Upholstery Furniture Design and Manufacture	2001
Tiajian Feng	A Constraint Network Approach to Software Testing	1998
Kittinan Unnanon	Computer-Aided Assembly Planning	1997

Invited Talks

I give approximately 10 invited talks per year and have given invited talks in the U.S., Canada, France, Germany, England, Ireland, Portugal, Japan, and China. For the sake of brevity, a small sampling of noteworthy talks are provided below. A full list is available upon request.

- **Keynote Address:** 2025 International Conference on Mechanics and Industrial Engineering, Paris France.
- **Keynote Address:** 2024 Solid Freeform Fabrication Symposium, Austin TX.
- **Keynote Address:** 2023 HIAM Conference, Halifax Nova Scotia.
- **Invited Talk:** 2023 Additive International Conference, Nottingham UK
- **Invited Talk:** 2023 Techblik Conference, Berlin Germany
- **Invited Talk:** 2022 Fulbright Faculty Fellow Address, Waterford Ireland
- **Keynote Address:** Vibration Institute Annual Conference, Rochester NY
- **Invited Talk:** 2017 CHINano Conference, Suzhou China
- **Plenary Address:** 2016 DURACOSYS Conference, Madeira Portugal
- **Keynote Address:** 2016 HPICS Conference, Seattle WA

Representative Courses Taught

RIT

ISE 789: Metal and Composite Additive Manufacturing

ISE 789: Personalized 3D Printing

ISE 789: Functional Printing

ISE 789: CAD/CAM

ISE 727: Advanced Manufacturing Processes

ISE 761: 3D Printing

ISE 801: Design for Manufacture and Assembly

Multidisciplinary Senior Design

North Carolina State University

ISE 216: Manufacturing Practicum

ISE 330: Furniture Product Engineering

ISE 453: Material Handling

ISE 514: Product Engineering

ISE 715: Manufacturing Process Engineering

ISE 791B: Rapid Prototyping and Manufacturing

Service Activities

- **RAPID + TCT Trade Show:** Serve on the RAPID + TCT Conference Organizing Committee (2009 – present)

- **International Scientific Advisory Committee** (Canada) – Holistic Innovation in Additive Manufacturing (HI-AM) Consortium
- **Additive Manufacturing Journal (Elsevier)** – Editorial Board member and reviewer.
- **Rapid Prototyping Journal (Emerald Publishing)** – Editorial Board member and reviewer.
- **NSF:** Serve as a research grant proposal reviewer for 3-5 panels per year for the National Science Foundation
- **Solid Freeform Fabrication Symposium** - Annual service at SFF Symposium to judge nominations for career achievement (FAME) awards, best paper awards, best poster awards, etc.
- **Consultant:** Frequently asked to serve as business and venture capital consultant to gauge commercial potential of new additive manufacturing technologies.
- **ASTM F-42** – Founding member of committee that develops standards pertaining to additive manufacturing processes and materials.
- **Navy Direct Digital Manufacturing of Metallic Components Workshop** - invited expert to help develop Navy's additive manufacturing research priority roadmap.
- **NSF Additive Manufacturing Roadmap** - invited expert to prepare a long term research-needs roadmap.