

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Alison N. Leonard et al.
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Title: DETECTION AND USE OF PRINTER CONFIGURATION
INFORMATION

DECLARATION OF DR. MICHAEL HICKNER

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LISTING OF CHALLENGED CLAIMS

Claim 1	
[1.pre]	A method comprising:
[1.1]	receiving a request to fabricate an object from a three-dimensional model;
[1.2]	determining a target printer to fabricate the object;
[1.3]	querying the target printer for configuration information of the target printer relevant to creation of a printable model for fabrication of the object on the target printer;
[1.4]	receiving, from the target printer, a dictionary of configuration information containing one or more properties from the target printer that affect fabrication capabilities of the target printer;
[1.5]	creating a fabrication profile based on the one or more properties; and
[1.6]	generating a machine-ready representation of the three-dimensional model executable by the target printer to fabricate the object.
Claim 2	

[2]	The method of claim 1 further comprising transmitting the machine-ready representation to the target printer for fabrication.
Claim 3	
[3]	The method of claim 1 further comprising fabricating the object with the target printer.
Claim 4	
[4]	The method of claim 1 wherein the one or more properties include a hardware configuration of the target printer.
Claim 5	
[5]	The method of claim 4 wherein the hardware configuration includes one or more of an extruder type, an extruder nozzle diameter, a build volume, a build platform type, a hardware version number, a top speed for linear movement of a tool, a step size for movement of the tool, a minimum z-axis size, a gantry type, and a build material type.
Claim 6	

[6]	The method of claim 4 wherein the hardware configuration includes an automatically detected hardware reconfiguration.
Claim 7	
[7]	The method of claim 4 wherein the hardware configuration includes a manually specified hardware reconfiguration.
Claim 8	
[8]	The method of claim 1 wherein the one or more properties include a firmware configuration of the target printer.
Claim 9	
[9]	The method of claim 1 wherein the one or more properties include one or more user settings on the target printer.
Claim 10	
[10]	The method of claim 9 wherein the one or more user settings include user setting from a previous fabrication process.
Claim 12	

[12]	The method of claim 1 wherein the one or more properties include a build material in the target printer.
Claim 13	
[13]	The method of claim 1 wherein generating the machine-ready representation includes processing the three-dimensional model according to the fabrication profile.
Claim 14	
[14]	The method of claim 1 wherein generating the machine-ready representation includes selecting one of a plurality of stored machine-ready models according to the fabrication profile as the machine-ready representation.
Claim 19	
[19]	The method of claim 1 further comprising generating descriptive metadata to accompany the machine-ready representation, the descriptive metadata specifying one or more properties for comparison to properties of printers selected for fabricating the model.

Claim 20

[20]	The method of claim 1, wherein determining a target printer to fabricate the object comprises determining a geographic location of the target printer.
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I, Michael Hickner, Ph.D., declares as follows:

I. INTRODUCTION

1. I have been retained as a technical expert by counsel on behalf of Shenzhen Tuozhu Technology Co., Ltd. (“Shenzhen Tuozhu” or “Petitioner”). I understand that Shenzhen Tuozhu is requesting that the Patent Trial and Appeal Board institute an *inter partes* review (“IPR”) proceeding with respect to U.S. Patent No. 11,886,774 (“the ’774 patent”) (EX-1001).

2. I have been asked to provide my independent analysis of the ’774 patent in light of certain prior art publications, and I have done so based on my personal knowledge and experience.

3. I am not, and never have been, an employee of Shenzhen Tuozhu. I received no compensation for this Declaration beyond my normal hourly compensation based on my time actually spent analyzing the ’774 patent, the prior art publications cited below, and various issues related thereto. I will not receive any added compensation based on the outcome of any IPR or other proceeding involving the ’774 patent.

II. QUALIFICATIONS

4. In formulating my opinions, I have relied on my knowledge, training, and experience in the relevant field. My education and experience are described more fully in my curriculum vitae (EX-1004). For ease of reference, I have

highlighted certain information below.

5. I have B.S., M.Eng., and Ph.D. degrees in Chemical Engineering. I began my chemical engineering education in 1994 and completed my Ph.D. in 2003 with an emphasis in polymer chemistry and polymer science.

6. Since 2003, I have been a researcher and professor in chemical engineering and materials science disciplines working for a number of organizations on polymers research including, specifically, polymers in the context of 3D printing technology.

7. I have taught college-level courses in chemistry, polymers, and materials science. Specifically related to this case regarding the '774 patent and additive manufacturing, I taught a graduate-level additive manufacturing course titled “Additive Manufacturing of Polymers and Composites” at Penn State University from 2018 to 2022. This course was part of the Additive Manufacturing and Design (AMD) graduate program that was started during my tenure at Penn State. The AMD graduate program covered all aspects of 3D printing—including how various build materials behave during a process to print a 3D part and support structure using multiple materials. In this course, and in my own research in 3D printing, I have used a wide range of 3D printing machines.

8. Similar teaching activities are planned at Michigan State University as I develop an additive manufacturing research program in my new role as an endowed

professor.

9. I have published a number of peer-reviewed journal papers that specifically address various aspects of additive manufacturing including aspects relating to printing equipment, printing strategies, and materials. For example, in papers that address extrusion 3D printing of silicones, we used different materials for the support structure and 3D part that helped with removal of 3D part from the support structure after printing.

10. Since 2013, I have been the principal supervisor for students pursuing advanced degrees in additive manufacturing and been a committee member on graduate committees in additive manufacturing topics.

11. In the course of my research and teaching at the university-level, I have worked with a wide range of 3D printers since 2012. I have purchased over twenty 3D printers for my research group. I have purchased more than ten 3D printers that can deposit more than one material to build 3D parts and/or support structures. I have printed a wide variety of materials in these printers, from ABS to composite polyimides.

III. LEGAL PRINCIPLES

12. In forming my analysis and conclusions expressed in this Declaration, I have applied the legal principles described in the following paragraphs, which were provided to me by counsel for the Petitioner.

A. Claim Interpretation

13. I understand that, for purposes of my analysis in this *inter partes* review proceeding, the terms appearing in the patent claims should be interpreted according to their “ordinary and customary meaning.” In determining the ordinary and customary meaning, I understand that the words of a claim are first given their plain meaning that those words would have had to a person of ordinary skill in the art at the time of the alleged invention. I also understand that the structure of the claims, the specification, and file history may be used to better construe a claim. Moreover, I understand that even treatises and dictionaries may be used, albeit under limited circumstances, to determine the meaning attributed by a person of ordinary skill in the art to a claim term.

B. Anticipation

14. I have been informed that a patent claim is unpatentable as anticipated under 35 U.S.C. § 102 if each and every element of a claim is found either explicitly or inherently in a single prior art reference. Under the principles of inherency, if the prior art necessarily functions in accordance with, or necessarily includes the claimed elements, it anticipates.

C. Obviousness

15. I have been informed that a patent claim is invalid as “obvious” in light of one or more prior art references if it would have been obvious to a person of

ordinary skill in the art at the time of the alleged invention (“POSITA”), taking into account (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of ordinary skill in the art, and (4) any so called “secondary considerations” of non-obviousness (e.g., evidence of “long felt need” for the claimed invention, commercial success attributable to the claimed invention, unexpected results of the claimed invention, and “copying” of the claimed invention by others).

16. While I do not know the exact date that the alleged invention of the ’774 patent was made, I do know that the ’774 patent’s earliest claimed priority date is December 31, 2014. For purposes of my obviousness analysis in the Grounds below, I have applied a date of December 31, 2014 as the date of the alleged invention (the “Critical Date”), although my opinions expressed below would hold true even if the date of the alleged invention were earlier, such as any time in the earlier 2010s.

17. I have been informed that a claim can be obvious in light of a single prior art reference or multiple prior art references. To be obvious in light of a single prior art reference or multiple prior art references, there must be a reason that would have prompted a POSITA to modify or supplement the single prior art reference, or to combine two or more references, in a manner that provides the elements of the claimed invention. This reason may come from a teaching, suggestion, or motivation

to combine, or may come from the reference(s) themselves, the knowledge or “common sense” of a POSITA, or from the nature of the problem to be solved, and this reason may be explicit or implicit from the prior art as a whole. I have been informed that, under the law, the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. I also understand it is improper to rely on hindsight in making the obviousness determination.

18. I understand that an obviousness determination also requires that a POSITA would have had a reasonable expectation of success. This concept has been explained to me as relating to the relative likelihood or predictability—from the perspective of a POSITA—of successfully modifying the prior art in a manner that would meet the claimed limitations of the patent being challenged (here the ’774 patent). I understand that the expectation of success need only be “reasonable” and, thus, does not require the absolute certainty gleaned from physically creating the proposed prior art modification.

IV. LEVEL OF ORDINARY SKILL IN THE ART

19. In rendering the opinions set forth in this declaration, I was asked to consider the patent claims and the prior art through the eyes of a person of ordinary skill in the art as of the effective filing date of the ’774 patent (“POSITA”), which I have concluded is December 31, 2014 for the reasons that I address in detail above

(§III.C). I understand that the factors considered in determining the ordinary level of skill in a field of art include the level of education and experience of persons working in the field; the types of problems encountered in the field; the teachings of the prior art; and the sophistication of the technology at the time of the alleged invention. I understand that a POSITA is not a specific real individual, but rather is a hypothetical individual having the qualities reflected by the factors above. I understand that a POSITA also would have knowledge from the teachings of the prior art, including the art cited below.

20. Taking these factors into consideration, on or before December 31, 2014, a POSITA relating to the technology of the '774 patent would have had at least a bachelor's degree in Mechanical Engineering, Computer Engineering, Electrical Engineering, or a comparable field and at least two years of experience related to 3D printers and software including remote control of rapid fabrication systems. Additional experience could substitute for a formal degree or formal training (and vice versa).

21. By December 31, 2014, my education and research experience was at least that of a POSITA. I am qualified to provide opinions concerning what a POSITA would have known and understood at that time, and my analysis and conclusions herein are from the perspective of a POSITA as of that date.

V. MATERIALS CONSIDERED AND RELIED UPON

22. In forming my opinions and reaching the conclusions described in this declaration, I have relied on the documents and materials cited herein as well as those identified in this declaration, including the '774 patent, the prosecution history of the '774 patent, and prior art references cited herein. These materials comprise patents, related documents, and printed publications. Each of these materials is a type of document that experts in my field would have reasonably relied upon when forming their opinions. I have also relied on my education, training, research, knowledge, and personal and professional experience in the relevant technologies and systems that were already in use prior to, and within the timeframe of the earliest effective filing date of the '774 patent (December 31, 2014).

23. Accordingly, as part of my independent analysis of the '774 Patent, I have analyzed the following publications and materials:

Exhibit	Description
EX-1001	U.S. Patent No. 11,886,774 to Leonard et al. ("the '774 patent")
EX-1002	Excerpts from the Prosecution History of the '774 Patent ("the Prosecution History")
EX-1005	U.S. Patent Pub. No. 2014/0117585 A1 to Douglas et al. ("Douglas")
EX-1006	U.S. Patent No. 9,694,544 to Mark et al. ("Mark")

Exhibit	Description
EX-1007	U.S. Patent Pub. No. 2014/0127524 A1 to Batchelder et al. (“Batchelder”)
EX-1008	European Patent No. 1087862B1 to Dahlin et al. (“Dahlin”)
EX-1009	U.S. Patent Pub. No. 2013/0329258 A1 to Pettis et al. (“Pettis”)
EX-1010	U.S. Patent Pub. No. 2014/0236773 A1 to Hamilton et al. (“Hamilton”)
EX-1011	<i>Practical 3D Printers, The Science and Art of 3D Printing</i> (“Evans”)
EX-1012	KISSlicer Quick-Start Guide (2012), available at https://web.archive.org/web/20121224171520/http://kisslicer.com/files/KISSlicerQuickStart.pdf#expand (“KISSlicer”)
EX-1013	Int. Patent Pub. No. 2014/039825A2 to Pax (“Pax”)
EX-1014	U.S. Patent No. 9,862,149 B2 to Wang et al. (“Wang”)
EX-1017	<i>Stratasys to Acquire MakerBot, Merging Two Global 3D Printing Industry Leaders</i> , published June 2013, available at https://investors.stratasys.com/news-events/press-releases/detail/19/stratasys-to-acquire-makerbot-merging-two-global-3d

24. My citations to non-patent literature throughout this Declaration reference the absolute page number added to the exhibit (as opposed to the original pagination of the document). For patent literature, I’ve used the column/line numbers or paragraph numbers. Unless I’ve indicated otherwise, all emphasis (bold/italics/underline) in any quoted text are ones I have added.

25. Although I cite and quote to selected portions of various references in this Declaration, the reader should understand that these citations are representative examples. A POSITA would have viewed each reference in its entirety and in combination with other references. Accordingly, I intend the references identified in this Declaration to be viewed as incorporated in their entireties.

VI. OVERVIEW OF THE '774 PATENT

A. Brief Description

26. Generally, the '774 patent purportedly provides for devices, systems, and methods for providing machine-ready models based on a printer's configuration in three-dimensional fabrication systems. EX-1001, Abstract, 2:49-3:7. In particular, the '774 patent generally describes “creating a fabrication profile based on ... one or more properties” of a three dimensional printer (e.g., a “build material type”). EX-1001, 19:26-45, 23:32-67. The fabrication profile can include “machine readable information for the slicer in creating a machine-ready model.” *Id.*

B. Prosecution History

27. The '774 Patent issued on January 30, 2024 from U.S. Patent Application No. 18/148,591 (“the '591 application”), which was filed on December 30, 2022 with 20 claims. EX-1002. The '591 application was allowed on its first action, generally stating that none of cited references disclose all of claim elements [1.3]-[1.6]. *Id.*, 16-17.

28. In the parent application (U.S. Patent Application No. 14/587,548 (“the ’548 application), now U.S. Patent 10,421,238), the applicant amended the claims in response to a §103 rejection based on Pettis (EX-1009) and U.S. Pat. Pub. No. 2014/0156053 (“Mahdavi”) to recite that the “dictionary” is received “from the target printer,” which the Examiner indicated as the reason for allowance. EX-1022 at 36-41, 80-88. The Examiner indicated that other claim elements of the ’548 application (e.g., “creating a fabrication based on the properties of the target printer,” identical to claim element [1.5] of the ’774 Patent) were disclosed in the prior art. *Id.* The Examiner also indicated claim elements “determining a target printer suitable for fabrication of the object,” “determining whether a suitable machine-ready model has previously been generated,” “generating a machine-ready model when it has not been previously generated,” and “transmitting the model to the printer for fabrication” were within the teachings of Pettis. *Id.*

VII. OVERVIEW OF CONCLUSIONS FORMED

29. This Declaration explains the conclusions that I have formed based on my independent analysis. To summarize those conclusions:

- Based upon my knowledge and experience, and my review of the materials listed above, I believe that Claims 1-5, 9-10, 12-13, and 20 of the ’774 patent are obvious in view of Douglas (EX-1005) and Mark (EX-1006). See Ground 1A at Section IX.A.

- Based upon my knowledge and experience, and my review of the materials listed above, I believe that Claims 6-7 and 9-10 of the '774 patent are obvious in view of Douglas, Mark, and Dahlin (EX-1008). *See* Ground 1B at Section IX.B.
- Based upon my knowledge and experience, and my review of the materials listed above, I believe that Claim 8 of the '774 patent is obvious in view of Douglas, Mark, and Batchelder (EX-1007). *See* Ground 1C at Section IX.C.
- Based upon my knowledge and experience, and my review of the materials listed above, I believe that Claim 19 of the '774 patent is obvious in view of Douglas, Mark, and Pax (EX-1009). *See* Ground 1D at Section IX.D.
- Based upon my knowledge and experience, and my review of the materials listed above, I believe that Claim 1-5, 9-10, and 12-13 of the '774 patent are obvious in view of Hamilton (EX-1010) and Evans (EX-1011), with or without KISSlicer (EX-1012). *See* Ground 2A at Section IX.E.
- Based upon my knowledge and experience, and my review of the materials listed above, I believe that Claims 6-7 and 19 of the '774 patent are obvious in view of Hamilton, Evans, and Pax (EX-1013),

with or without KISSlicer. *See* Ground 2B at Section IX.F.

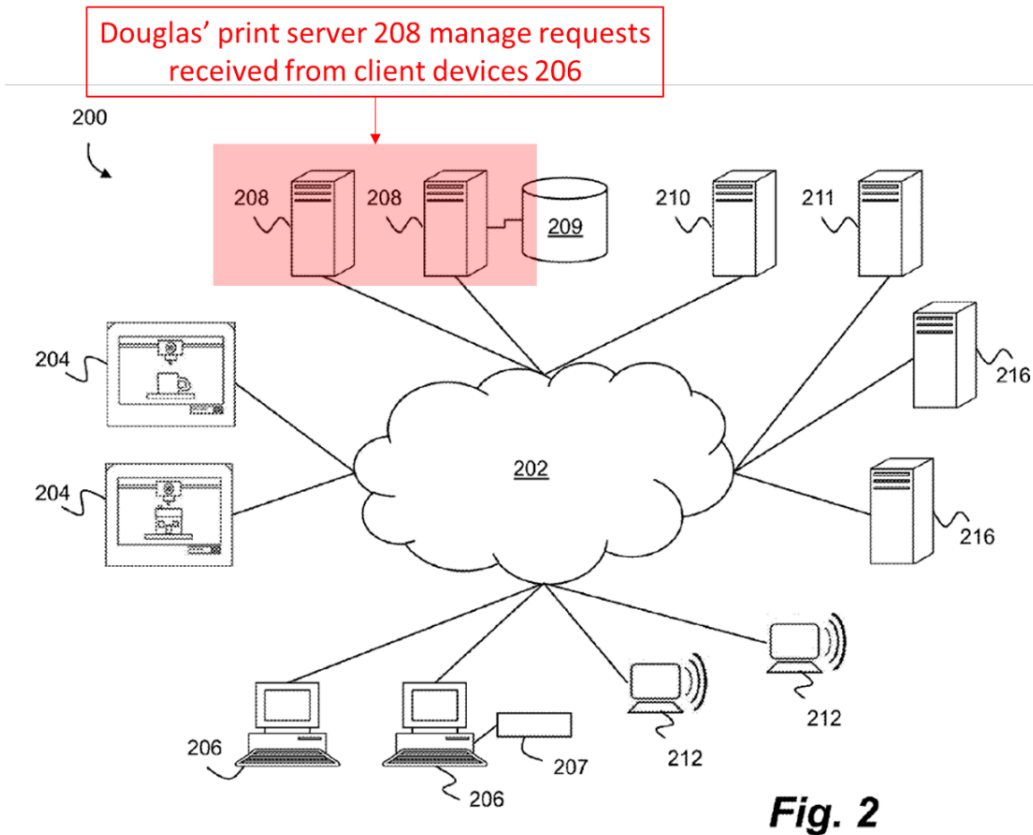
- Based upon my knowledge and experience, and my review of the materials listed above, I believe that Claim 19 of the '774 patent is obvious in view of Hamilton, Evans, Pax, and Pettis, with or without KISSlicer. *See* Ground 2C at Section IX.G.
- Based upon my knowledge and experience, and my review of the materials listed above, I believe that Claim 8 of the '774 patent is obvious in view of Hamilton, Evans, and Batchelder, with or without KISSlicer. *See* Ground 2D at Section IX.H.
- Based upon my knowledge and experience, and my review of the materials listed above, I believe that Claim 20 of the '774 patent is obvious in view of Hamilton, Evans, and Wang (EX-1014), with or without KISSlicer. *See* Ground 2E at Section IX.I.

VIII. OVERVIEW OF THE CITED REFERENCES

A. Douglas

30. Douglas discloses a “networked three-dimensional printing environment” that includes one or more 3D printers (e.g., 204) and print servers (e.g., 208). EX-1005, ¶[0026], FIG. 2. The 3D printer reads a “data tag” on the build material that “includes information about the build material.” EX-1005, ¶¶[0004], [0032], [0062]-[0065], [0072]-[0073], FIGS. 2, 3, 6. In some cases, print jobs in

Douglas are managed by a “print server” that receives requests from a remote user, queries printers for their data tags, and determines suitable printers to complete the requested print job based on the data tag information, among other things. EX-1005, ¶¶[0026]-[0032], [0072]-[0073], FIGS. 2, 6. Douglas’ print server determines operational parameters for fabrication of the object in the request based on received data tag information. EX-1005, ¶¶[0032], [0072]-[0073], [0097] FIGS. 2, 6. FIG. 2 below shows an example system in Douglas.

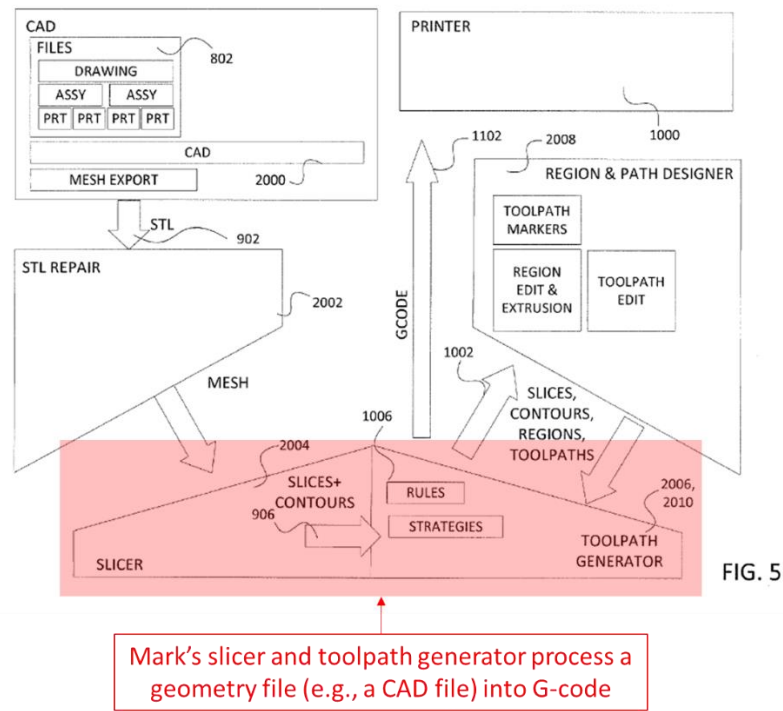


EX-1005, FIG. 2.¹

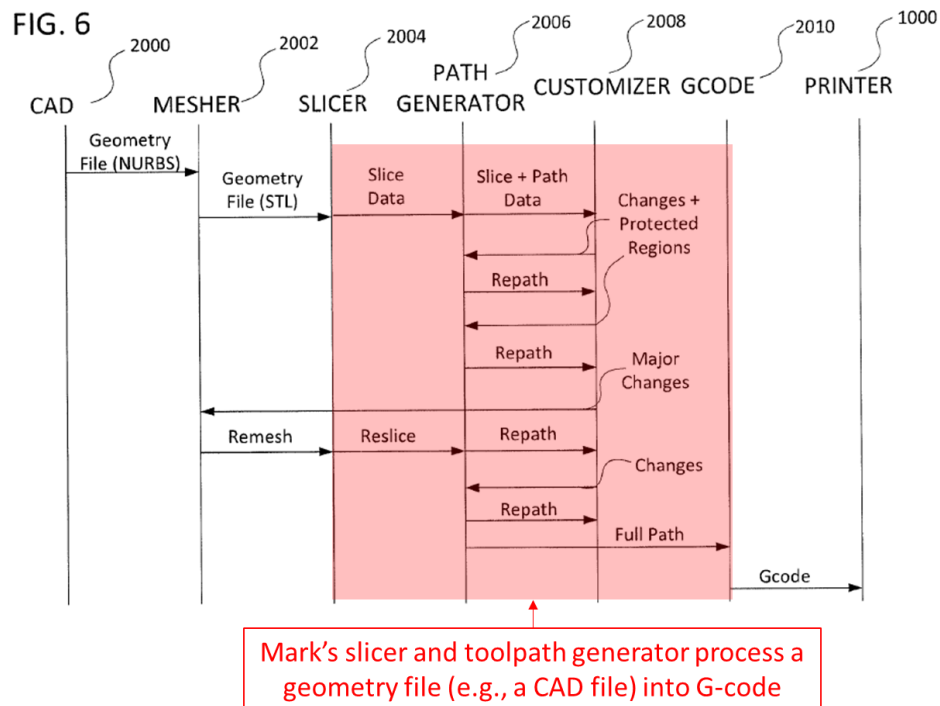
¹ Annotations to figures are shown in color.

B. Mark

31. Mark also “relate[s] to three dimensional printing” and discloses in a 3D printing process to fabricate an object, upon “receiving a three-dimensional geometry,” a slicer is used for “slicing [the] three-dimensional geometry into layers” and a “toolpath generator” is used for “generating three-dimensional toolpath instructions.” EX-1006, 1:25, 48-61; 11:4-13:3, FIG. 5-6. The “toolpaths are used to create an instruction file for actuation, conventionally called a ‘G-code’ file, which is sent to the 3D printer. EX-1006, 12:15-25, FIG. 5. The “G-code” file includes “all starting and finishing times, control or command variables (e.g., speed for a motor, current for a heater), and the like, to arrange the actuator instructions sufficient for a job to complete.” EX-1006, 12:15-32, FIGS. 5-6. FIGS. 5 and 6 below show an example process for generating G-code from a geometry file.



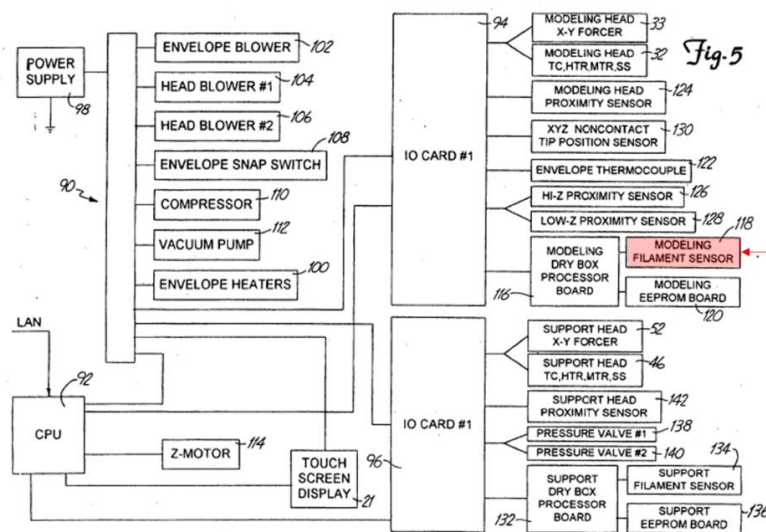
EX-1006, FIG. 5.



EX-1006, FIG. 6.

C. Dahlin

32. Dahlin discloses a 3D printer filament spool that includes “a circuit for monitoring data concerning the filament on the filament spool,” for example, “the type and amount of filament on the spool.” EX-1008, ¶¶[0007]-[0008], FIG. 1. Additionally, Dahlin discloses that this circuit can “notify the operator if the type of filament does not match the type of material identified by object specification data or if the amount of filament on the spool is insufficient to create a desired object.” EX-1008, ¶¶[0007]-[0008], [0022]-[0023], FIGS. 1, 5. If the loaded materials are different than what the print requires, or the loaded materials are insufficient, “operator notification is provided via touch screen display 21, providing the operator an opportunity to switch spools.” *Id.* An example system in Dahlin is shown below in FIG. 5.



Dahlin's filament sensor monitors the type and amount of filament loaded in the printer

EX-1008, FIG. 5.

D. Batchelder

33. Batchelder discloses “marked consumable material for use in an additive manufacturing system,” i.e., 3D printing system. EX-1007, Abstract, ¶¶[0008]-[0010]. Batchelder discloses information relative to the material and 3D printer, such as, “software and firmware updates for [the 3D printing] system 10,” are read by a sensor assembly and “transmitted to ... control components for generating a build path for depositing roads of modeling material to form [a] 3D model.” EX-1007, ¶¶[0006], [0030]-[0031], [0043], [0052]-[0054].

E. Hamilton

34. Hamilton discloses a “product delivery system” where a product is “manufactured locally using a 3D printer.” EX-1010, Abstract, ¶¶[0001], [0014]-[0017], FIG. 1. This process includes querying the 3D printer’s “accuracy and material capabilities”/“abilities” to fabricate the object such as “an indication of a material stock available to the 3D printer.” EX-1010, ¶¶[0016]-[0019], [0021], FIG. 3. An example process for manufacturing an object is presented below in FIG. 3.

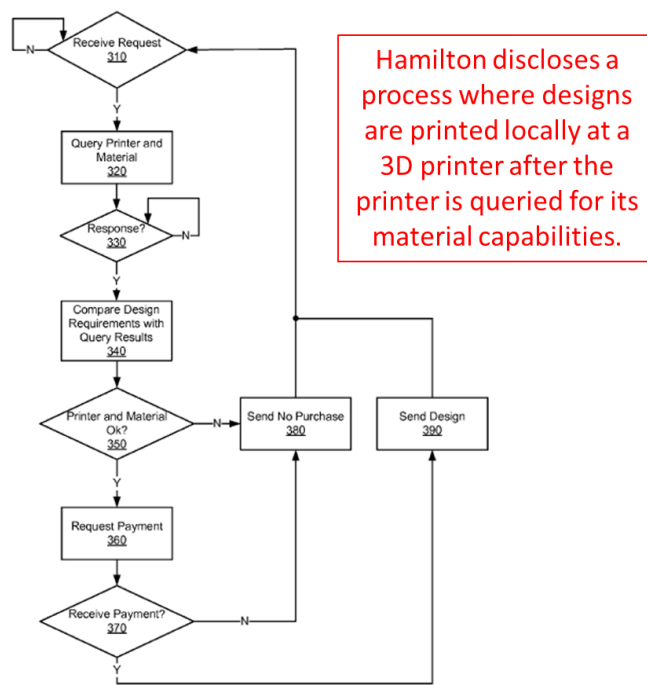


Fig. 3

EX-1010, FIG. 3

F. Evans

35. Evans is a “how-to manual” for 3D printing that includes a “big picture of how 3D printers work” along with “specifics of a 3D printer’s toolchain.” EX-1011, 5. Included within Evans’ comprehensive disclosure is an overview of an application called a “slicer” that takes the 3D model of an object and “slice[s] it into layers suitable for 3D printing” according to “Print Settings” that include “Printer and Filament” and “Print Speed,” as well as “specific print setting for the job.” EX-1011, 43-44, 62-70, 312. Evans explains that “[t]his process makes the code that tells the 3D printer where to move the extruder, when to extrude plastic, and how much plastic to extrude.” *Id.*

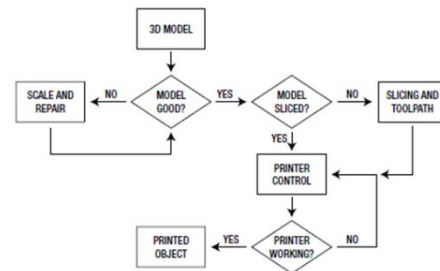
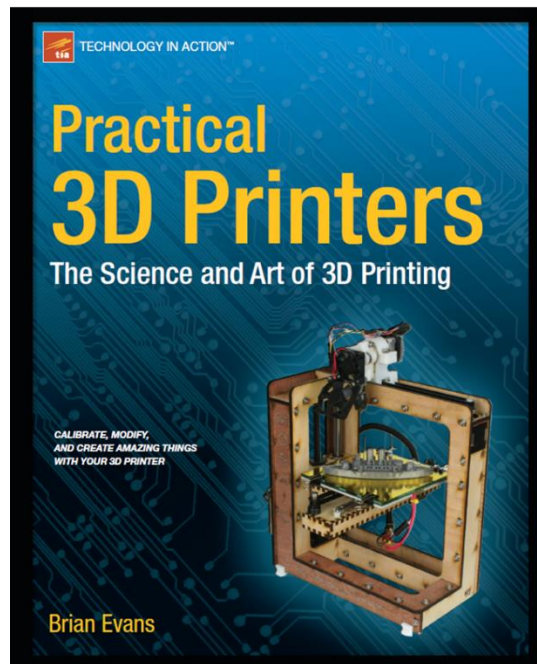
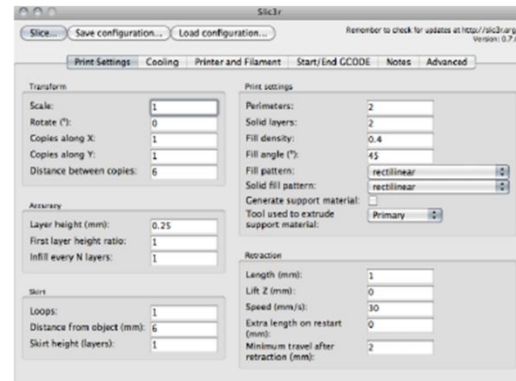


Figure 2-1. 3D printer workflow

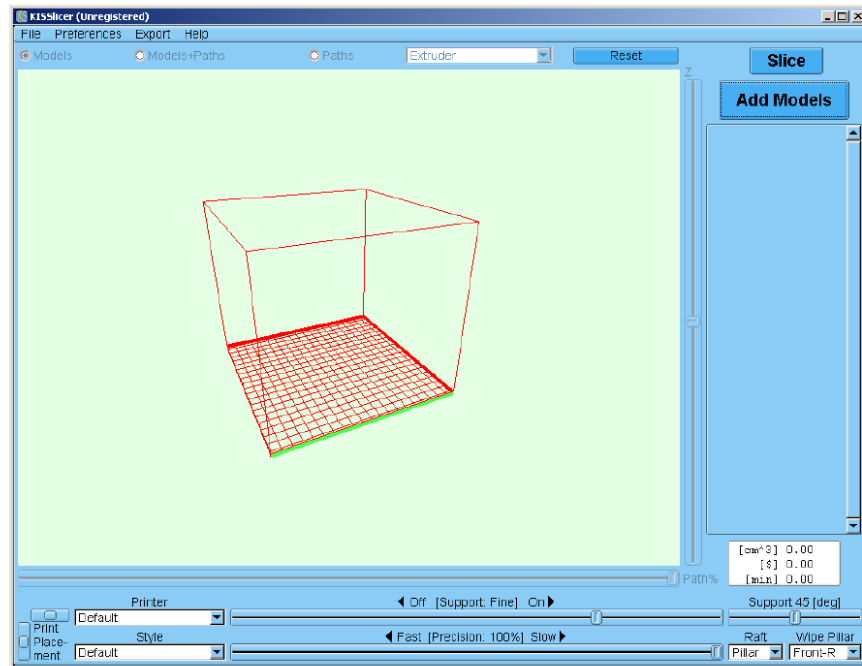


Evans is a comprehensive 3D printing reference, and includes an overview of various slicing programs and 3D printer control software

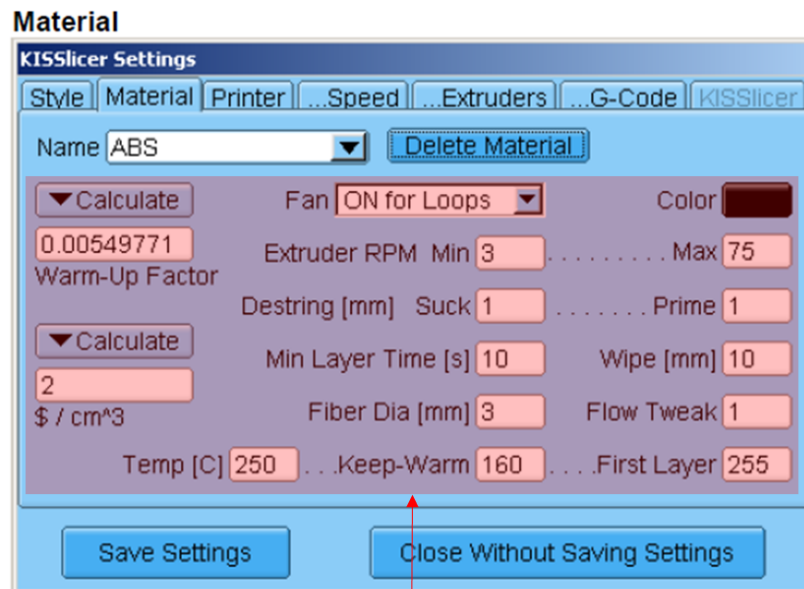
EX-1011, Cover, 34, 46 (cropped and merged).

G. KISSlicer

36. KISSlicer is a quick-start user guide of another slicer application, KISSlicer, similar to other example slicers discussed in Evans above. EX-1012, 1-11; *see above*, §VIII.F. As shown in an example user interface below, KISSlicer describes how to use the slicer to “Slice” a model and create a file (e.g., G-code) according to one or more settings such as “Style,” “Material,” “Printer” settings. EX-1012, 1-9. KISSlicer explicitly refers the settings as “profile” (e.g., Printer profiles, Material profiles), which are created based on “printer parameters” and “saved.” EX-1012, 2-4, 8.



An example KISSlicer profile is illustrated below.



KISSlicer creates a profile based on a specific material (Acrylonitrile Butadiene Styrene ("ABS"))

EX-1012, 3.

H. Pax

37. Pax is directed to a 3D printer that can mix different build materials to achieve an “output over a full color spectrum” (e.g., by mixing red, green, and blue build material). EX-1013, ¶¶[0064]-[0067], FIG. 3A. Pax’s techniques include identifying “the color and material requirements for fabricating the object,” e.g., “in metadata of the object model” and performing a “pre-fabrication check” that compares available build materials of a selected printer with “the color and material requirements” of the model,” EX-1013, ¶¶[0096]-[00101], FIG. 11. Pax also discloses determining “the types, amounts, and colors of available build materials,” either automatically or by querying the user (shown below in FIG.11). EX-1013, ¶¶[0097]-[00101], FIG.11. In the event the available build materials are inadequate, the user is notified. *Id.*

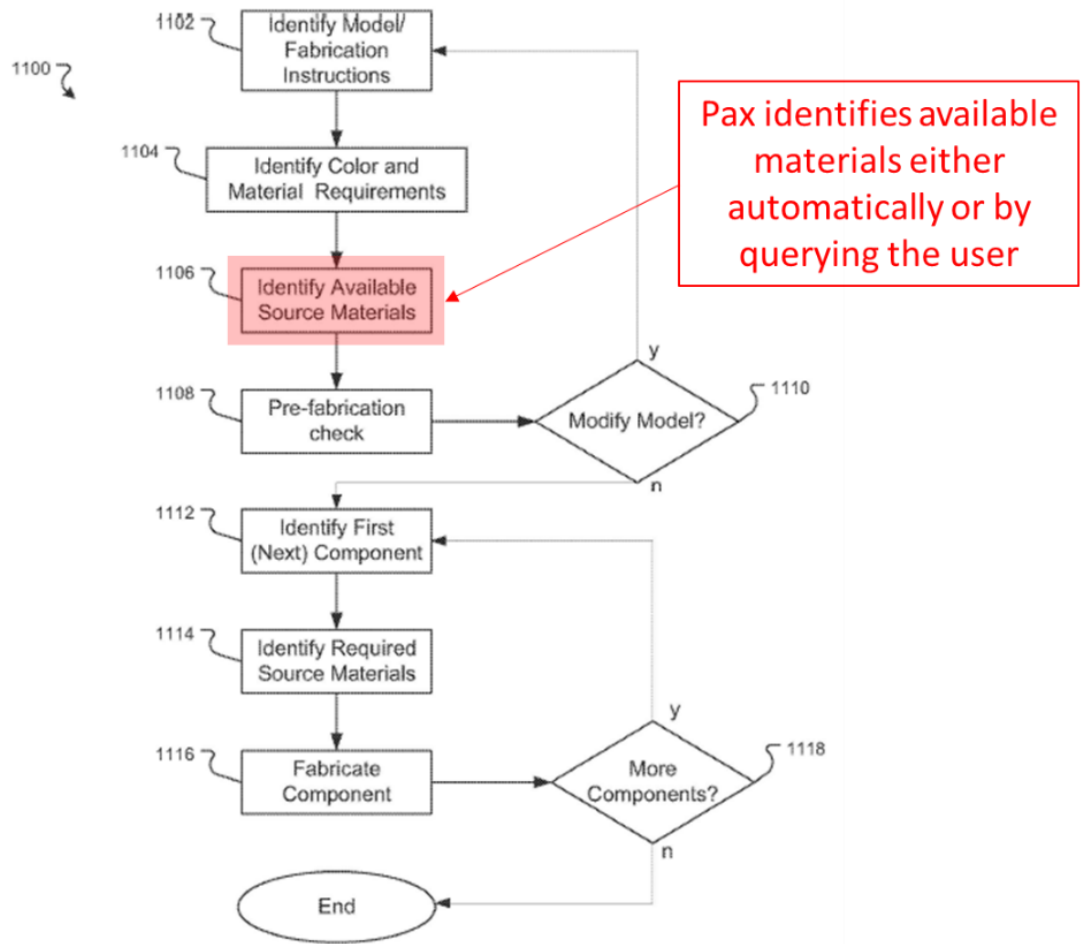


FIG. 11

EX-1013, FIG.11.

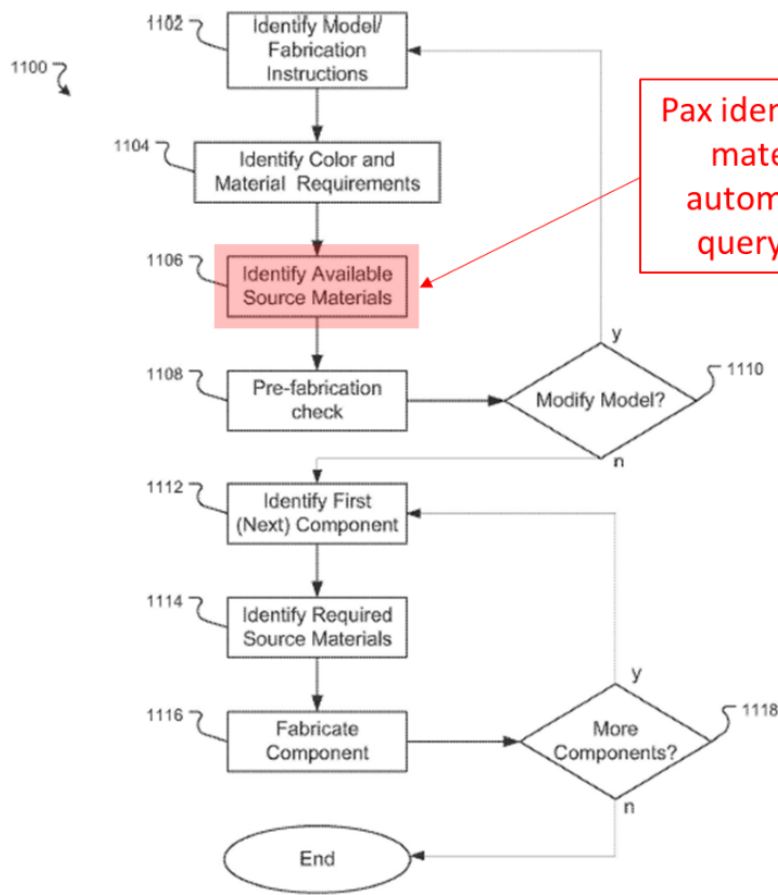


FIG. 11

EX-1013, FIG. 11.

I. Pettis

38. Similar to Douglas, Pettis discloses “a networked three-dimensional printing environment” that includes “any number of three-dimensional printers 204” and “print servers 208,” etc. EX-1009, ¶¶[0024]-[0041], FIG. 2. The “server automatically determines a printer type and selects a suitable, corresponding machine-ready model for immediate fabrication by the printer.” EX-1009, Abstract, ¶[0004]. Pettis further discloses a data structure 300 that includes metadata 308 that

accompanies multiple different machine-ready models 314 generated by a server for a 3D model 304 for use in selecting a suitable printer and verifying the suitability of the selected printer, similar to the '774 patent's disclosure. EX-1009, ¶¶[0061]-[0067] (disclosing that “A verification engine 316 may also be included **to verify the suitability of machine-ready models 314 for fabrication on an intended device**” and “verification may be performed selectively, e.g., for popular printer types, and each machine-ready model 314 may be annotated in the **metadata 308** or within the model 314 to indicate whether it has been successfully fabricated), [0080], FIG. 3; EX-1001, 1:46-52 (disclosing that metadata is generated after the server has determined a target printer and used for checking “to ensure that the model can be fabricated by the printer.”).

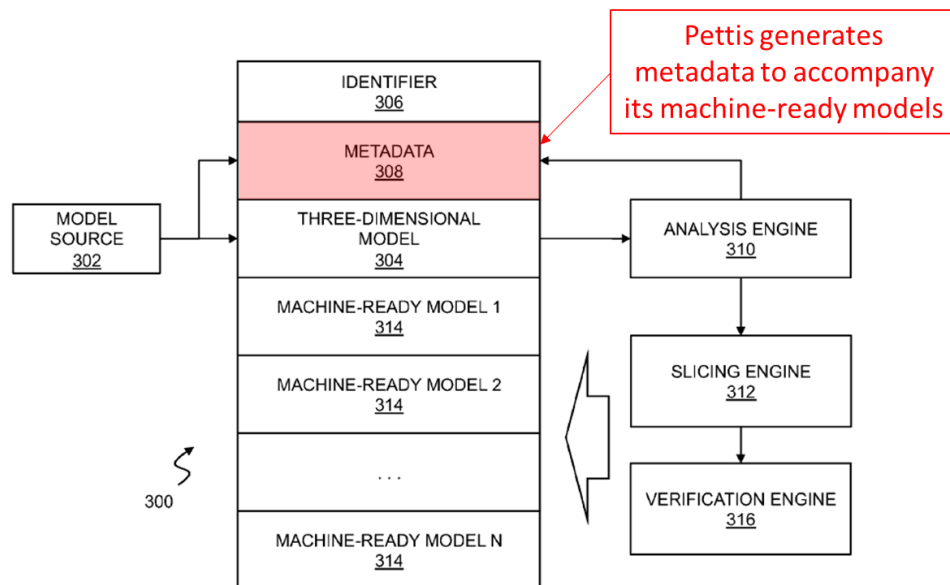


Fig. 3

EX-1009, FIG. 3.

J. Wang

39. Wang is directed to “techniques for providing 3D printing services” using multiple “3D printing bureaus” (that include 3D printers). EX-1014, 2:19-53, FIG. 2. Similar to Hamilton, Wang’s techniques “provide an additional layer of processing between the design tool of the customer and the 3D printer of the printing bureau” that includes “verifying printability of the 3D models, analyzing and adjusting the model data to improve print quality and efficiency, converting 3D models into accepted formats, and implementing vendor specific software for transferring 3D model files to printing bureaus.” *Id.* Wang also determines the “geographical location of the printer” associated with the print bureau. EX-1014, 7:60-8:5.

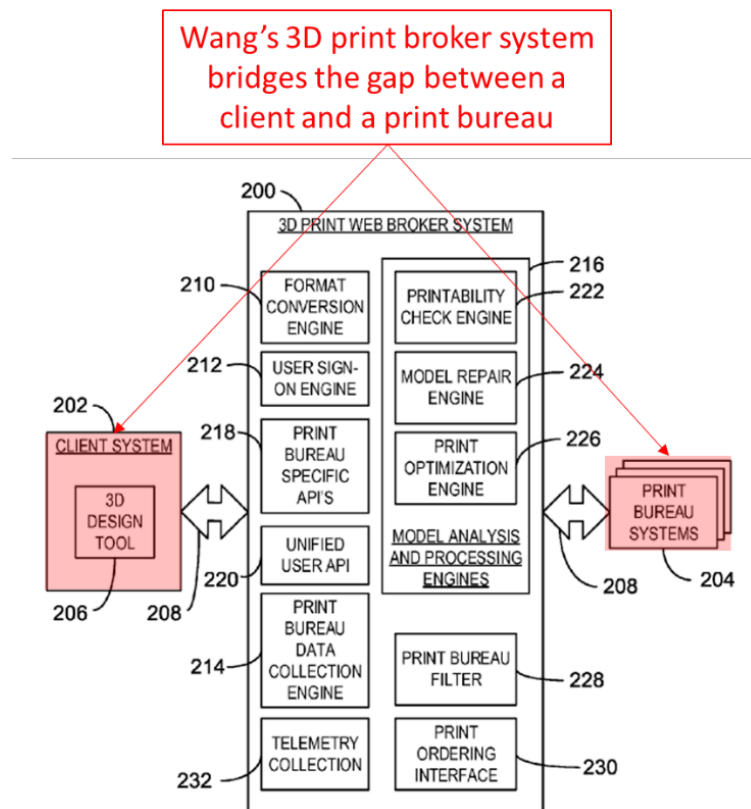


FIG. 2

EX-1014, FIG. 2.

IX. APPLICATION OF THE CITED REFERENCES TO THE CHALLENGED CLAIMS

A. GROUND 1A—Douglas in view of Mark renders claims 1-5, 9-10, 12-13, 20 obvious

1. A POSITA would have combined Douglas and Mark

40. A POSITA would have been motivated to implement Douglas' system in a manner that employs Mark's teaching of a full featured slicer and toolpath generator configured to process (e.g., slice) a 3D model into layers and generate

toolpath instructions (e.g., G-code) according to operational parameters that reflect the fabrication capability of the 3D printer, including Mark's use of operational parameters arranged as a configuration file, a rule set or parameter database and Mark's express teaching of transmitting the generated G-code to a printer, such as the printer selected by Douglas. EX-1005, ¶¶[0032], [0072]-[0073], [0097]-[0099], FIGS. 2, 6; EX-1006, 1:25, 48-61; 11:4-13:3. A POSITA would have been motivated to combine Douglas and Mark for at least the following reasons.

41. First, Douglas discloses a printer server determines a suitable printer to complete a print job received from a client with a focus on obtaining the printer's capabilities to determine operational instructions and print data (e.g., "tool instructions to fabricate the object") for execution by the selected printer. EX-1005, ¶¶[0013], [0032]-[0039], [0040]-[0043], [0072]-[0073], FIGS. 2, 6. A POSITA implementing 3D printing based on Douglas' system would have been motivated to look to references that disclose implementation details for generating print data (e.g., tool instructions) for FDM printers. Mark is such a reference, which discloses that 3D printing in "Fused Filament Fabrication (FFF)" (also known as FDM) includes "generating three-dimensional toolpath instructions for a three dimensional printer" from "three-dimensional geometry" (e.g., models submitted as print jobs in Douglas' system). EX-1006, 1:48-61. Mark's slicer and toolpath generator create instructions that include "all starting and finishing times, control or command variables (e.g.,

speed for a motor, current for a heater), and the like, to arrange the actuator instructions sufficient for a job to complete” (e.g., instructions to complete Douglas’ print jobs). EX-1006, 12:15-32, FIGS. 5-6. These details would have assisted a POSITA in implementing Douglas’ system. EX-1006, 11:4-13:3, FIGS. 5-6.

42. Second, a POSITA would have recognized and found obvious that fabricating an object using a 3D printer would have used code/instructions executable on the 3D printer to control the 3D printer, and such code/instructions is typically generated by a slicer and toolpath generator. EX-1011, 34. A POSITA would have understood and found obvious that code or instructions executable on the 3D printer to control the printer (e.g., G-code) would be the most accurate if a slicer and toolpath generation software were used, rather than coding the printer instructions by hand, where errors are more likely. Mark discloses a suitable, full featured slicer and toolpath generator. EX-1006, 11:4-13:3. In fact, most early print engine software was generated by slicer routines and was not coded by hand. Early adopters of 3D printing nearly all used slicing software instead of hand-coding machine-ready instructions.

43. Third, Mark’s techniques had certain advantages a POSITA would have saw as beneficial in Douglas’ system, e.g., facilitating data transmission and printing efficiency by collecting Douglas’ operational parameters in a file/set/database. For example, Mark’s techniques can attempt to “repair” improperly generated 3D

models, which would have allowed a means to recover bad models submitted with a print job. EX-1006, 12:40-48, 13:65-14:13. For example, prior to slicing the model, Mark performs a “pre-processing step” that “corrects the STL file for various errors” (e.g., correcting face normal orientation,” “self-intersections,” “erroneous holes or cavities,” etc). *Id.* Correcting these issues with Mark’s pre-processing step would have been beneficial to ensure models submitted in Douglas’ print jobs are suitable for the selected printer to execute, which would have reduced the need to reject user submitted print jobs. *Id.*; EX-1014, 2:19-53 (describing that repairing models prior to printing can improve service to customers).

44. Douglas and Mark are analogous art to the ’774 patent, which is generally directed to “the use of configuration information for a three-dimensional printer to select suitable machine-ready models.” EX-1001, 1:15-20. Douglas is generally related to “three-dimensional printers using fused deposition modeling or similar techniques,” and Mark is generally related to “three dimensional printing,” and also related to “Fused Filament Fabrication (FFF)” techniques (also known as Fused Deposition Modeling (FDM)). EX-1005, ¶¶[0012]-[0015], FIG. 1; EX-1006, 1:25, 4:7-11, 6:40-44. Accordingly, the prior art references are all directed to the same field of 3D printing. *Id.*

45. Additionally, as explained below in more detail, combining Douglas and Mark would have been obvious at least because such a combination would have

merely involved (1) combining prior art elements according to known methods to yield predictable results; and the (2) use of known technique to improve similar methods in the same way.

46. Incorporating Mark's teachings into Douglas would have been predictable and foreseeable with a reasonable expectation of success because the use of slicing applications to generate machine-ready code (e.g., "G-code") has "been around for a while." EX-1011, 34. Slicers were well known and commonly used before the Critical Date. *See e.g.*, EX-1012, 3-4; EX-1015. Additionally, it would have been within the knowledge and skill of a POSITA to, for example, acquire and install a slicing application such as described by Mark to process Douglas' models. To the extent that the combination involves any sophisticated coding or programming skill, a POSITA would have an understanding of what could be done in software and could implement the combination by instructing and further working with programmers to code it, if needed, with a reasonable expectation of success. Further, Mark already uses some of Douglas' operational parameters to generate the G-code (e.g., "feed rate," fill "density" and "pattern," "fiber type"). EX-1005, ¶[0065]; EX-1006, 12:15-32, 24:21-31, FIGS. 20-21.

Fig. 20 RULE/PARAMETER DATABASE

Toolpath N...M	Trajectory Definition		Material	
Region N...M	Fill Density		Fill Pattern	
Region N...M	Use Fiber (T)	Fiber Layers (3)	Fiber Type (F, CAF)	Concentric Rings (2)
Layer N...M	Pause After Layer (T)			
Layer N...M	Use Fiber (T)	Fiber Layers (3)	Fiber Type (F, CAF)	Concentric Rings (2)
Layer N...M	Fill Density		Fill Pattern	
Global	Wall Layers (3, 2-5)			
Global	Roof & Floor Layers (4, 2-10)			
Global	Use Fiber (T)	Fiber Layers (3)	Fiber Type (F, CAF)	Concentric Rings (2)
Global	Use Supports (T)		Support (S, P)	
Global	Fill Density		Fill Pattern	

Example printer properties in Mark that are similar to Douglas' operational parameters

EX-1006, FIG. 20.

2. Analysis

[1.pre] A method comprising:

47. Douglas discloses “three-dimensional printers using fused deposition modeling or similar techniques,” and further that its techniques can be implemented as a “**method.**”² EX-1005, ¶¶[0011]-[0015], FIGS. 1, 6. See also Mark, titled “Methods for fiber reinforced additive manufacturing.” EX-1006.

² All emphasis is added unless otherwise noted.

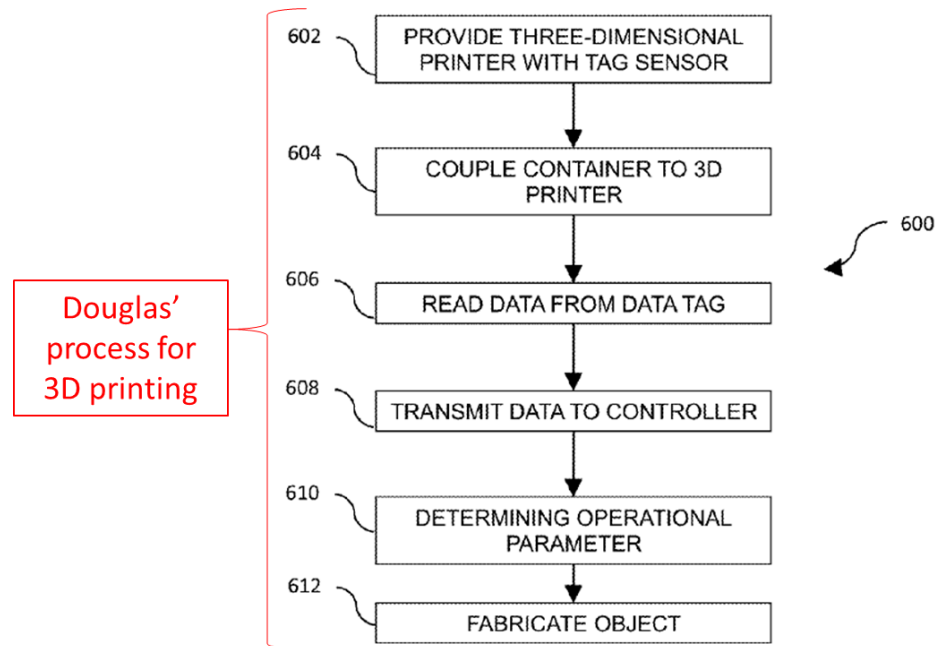


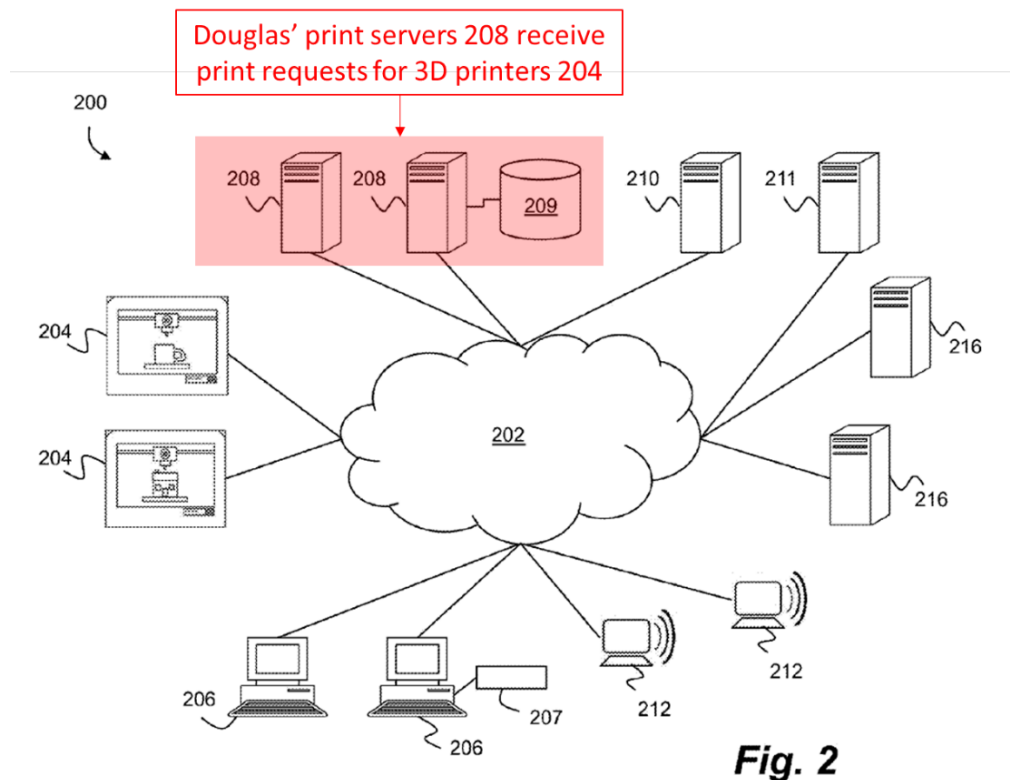
Fig. 6

EX-1005, FIG. 6.

[1.1] receiving a request to fabricate an object from a three-dimensional model;

48. Douglas discloses that print server 208 receives and manages print jobs originated from “client devices 206” which can “initiate ... print jobs at the three-dimensional printers 204” (“***receiving a request to fabricate an object ...***”). EX-1005, ¶¶[0030]-[0046], [0052], FIG. 2. These client requests are from “a remote user requesting a print job” and include “digital models of three-dimensional objects,” and the print job is associated with “print data (e.g., the three-dimensional model ... to fabricate an object)” (“... ***from a three-dimensional model***”). EX-1005, ¶[0031]. Douglas further makes it clear that the

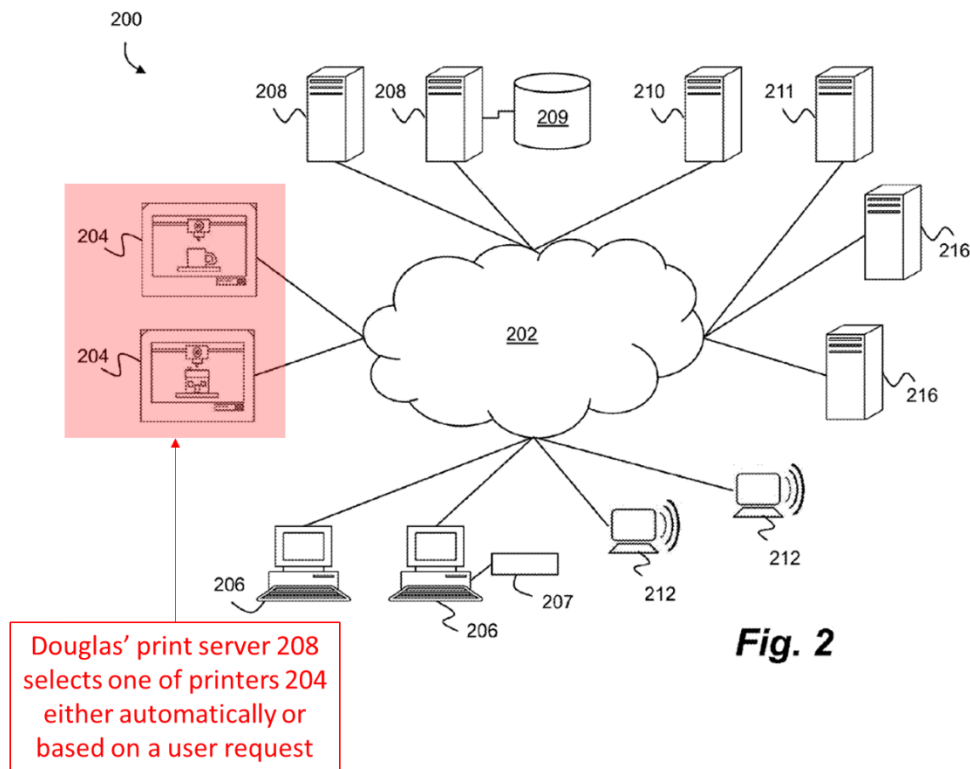
received printer job is a ***request to fabricate an object from a three-dimensional model*** because the print jobs are included in a print queue that includes print data (e.g., the three-dimensional model ... to fabricate an object) for a number of print job. EX-1005, ¶¶[0040]-[0041]. This is consistent with the '774 patent, which similarly describes that a three-dimensional model can be “a computer model or other computerized representation of the object such as an STL file containing a polygonal mesh or the like characterizing an object in three dimensions.” EX-1001, 18:10-41.



EX-1005, FIG. 2.

[1.2] determining a target printer to fabricate the object;

49. Douglas discloses that its “print server 208” can “automatically select one of the three-dimensional printers 204 for a user-submitted print job, or may permit a user to specify a single printer, or a group of preferred printers, for fabricating an object” (“determining a target printer to fabricate the object”). EX-1005, ¶¶[0032], [0038]-[0043], [0073], FIG. 2. For example, print server 208 can host a “virtual workspace” that allows a user to “direct fabrication of a model developed within that environment on a user-specified one of the three-dimensional printers 204.” EX-1005, ¶[0043]. In either case, the “print server 208” would “***determine[] a target printer***” by “automatically select[ing]” a printer or identifying the user-selected printer. EX-1005, ¶¶[0032], [0038]-[0039], [0043], [0073].



EX-1005, FIG. 2.

[1.3] querying the target printer for configuration information of the target printer relevant to creation of a printable model for fabrication of the object on the target printer;

50. Per claim element [1.4] and claims 4 and 5 of the '774 patent, the “**configuration information containing one or more properties**” encompass at least “**a build material type.**” EX-1001, claims 1, 4, and 5. The Specification also makes it clear that “the dictionary [of one or more properties from the target printer] may include properties of the build material.” EX-1001, 22:56-23:5.

51. Douglas discloses that the print server can “request the three dimensional printer 306 to transmit the data tag 304 data for one or more of the

connected supplies 302 for the determination of operational parameters” (*“querying the target printer for configuration information of the target printer ...”*). EX-1005, ¶¶[0032], [0072]-[0073], FIGS. 2, 6. The data tag data includes *configuration information of the target printer relevant to creation of a printable model for fabrication of the object on the target printer* because it “characterize[s] at least one property of the build material” of the printer, to include “characteristic information appropriate for a three-dimensional printer” and Douglas explains that “three-dimensional printers use build material of various type and configuration to print three-dimensional objects. In order to properly process the build material through the three-dimensional printer extruder for the fabrication of an object, the three-dimensional printer controller may need at least a basic set of characteristics of the build material to determine operation.” EX-1005, ¶¶[0002], [0032], [0064], [0072]-[0073], [0094].

[1.4] receiving, from the target printer, a dictionary of configuration information containing one or more properties from the target printer that affect fabrication capabilities of the target printer;

52. The ’774 patent describes “[t]he dictionary may be a list or collection of the properties, or may be otherwise configured to organize the properties of the printer.” EX-1001, 21:24-26. Douglas’ accumulated data tag 304 data received from the printer constitutes *a dictionary of configuration information* because it also includes a list or collection of “information on characteristics of the build

material 312” (“**one or more properties**”) which “may include 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, a build material expiration date, or other characteristic information appropriate for a three-dimensional printer.” EX-1005, ¶¶ [0062], [0064].

53. As discussed above in [1.3], after an inquiry from the print server, Douglas’ 3D printers transmit and the print server receives the “data tag 304 data” for “determination of the operational parameters for fabrication of the object 314” (“**receiving, from the target printer, a dictionary of configuration information containing one or more properties from the target printer**”). EX-1005, ¶¶[0019], [0032], [0072]-[0073], [0097], FIGS. 2, 6; *see above*, [1.3]. For example, Douglas explains “a build material type” can affect fabrication capabilities of the target printer. *See e.g.*, EX-1005, ¶[0019] (disclosing “deliver[ing] build material at a controlled volumetric rate, which may depend upon the type of build material”) and ¶[0097] (disclosing “based upon the type of build material, the controller may determine a variety of parameters such as an extruder temperature, a feed rate, ..., an extruder movement speed.”). As

discussed above, the data tag data includes “information on characteristics of the build material 312” (“***one or more properties from the target printer that affect fabrication capabilities of the target printer***”) such as “a build material type” available to the printer would have needed to match the object to be printed. *Id.* The material type also affects “temperature,” “feed rate,” and “extruder movement speed” (“***fabrication capabilities***”), which, as Douglas notes, “depend up-on the type of build material.” See e.g., EX-1005, ¶¶[0019] (disclosing “deliver build material at a controlled volumetric rate, which may depend upon the type of build material,” [0097] disclosing “based upon the type of build material, the controller may determine a variety of parameters such as an extruder temperature, a feed rate, ...an extruder movement speed”).

[1.5] creating a fabrication profile based on the one or more properties; and

54. As discussed above in [1.3] and [1.4], Douglas’ print server determines operational parameters for fabrication of the object (“***creating a fabrication profile ...***”) based on data tag information (“... ***based on the one or more properties***”). EX-1005, ¶¶[0032], [0065]-[0066], [0072]-[0073], [0097], FIGS. 2, 6; see above, [1.3], [1.4]. A POSITA would have recognized and found obvious that determining operational parameters for fabrication of the object would have been “creating a fabrication profile” as these operational parameters

are used “for a fabrication process using the build material 312” and “for the fabrication of the object 314.” EX-1005, ¶¶[0064], [0074]. For example, Douglas explains that “information about the build material stored in the data tag may be used to determine how the build material should be used in a fabrication process.” EX-1005, ¶[0097].

55. Douglas makes it clear that “the operational parameter(s)” are used in “fabricating an object ... to control operation of a three-dimensional printer,” consistent with the ’774 patent’s disclosure that “[t]he fabrication profile may be the basis for the generation of a machine-ready representation” that “contains instructions that can be directly executed on the target printer” to control the target printer “for fabrication of the object.” EX-1005, ¶¶[0064]-[0066], [0069], [0077], [0097], [0099]; EX-1001, 23:34-41.

56. Operational parameters are determined in Douglas to determine the suitability of the target 3D printer to print the object defined by the 3D model, which is consistent with the ’774 patent’s characterizing of the “fabrication profile” being “a profile used to determine which machine-ready representation is available or suitable for a target printer”). EX-1005, ¶¶[0064]-[0066], [0069], [0077], [0097], [0099]; EX-1001, 23:50-52. A POSITA would have also recognized and found obvious that the accumulation of operational parameters constitutes a “profile,” or that a “profile” would have been created based on Douglas’

operational parameter(s) for a collection/accumulation of information/parameters related to the printer for better data transmission and efficiency because Douglas describes there can be “a variety of [operational] parameters” which would be transmitted to the 3D printer. EX-1005, ¶¶[0073], [0097]. By compiling them together in a profile as a collection/accumulation of parameters, it would have facilitated the data transmission and improve the printing efficiency. Douglas also discloses that the various operational parameters can be configured as “default operational parameters that a user can override if further customization of a fabrication process is desired” or be automatically created “without [a user’ manually] specifying various configuration details.” EX-1005, ¶[0073], [0097], [0099]. By compiling them together in a profile as a collection/accumulation of parameters, it would have facilitated data compilation, organization, and storage to improve user experience with the options of loading default or automatically generated various operational parameters.

57. Additionally, to the extent it is argued that Douglas alone does not render this limitation obvious, a POSITA would have also recognized and found obvious that Douglas’ operational parameters (including, e.g., a material type, “feed rate”) are similar to the parameters included in a “configuration file” or “rules”/“rule sets”/“parameter database” in Mark, which are essentially “data structures defining operations.” EX-1005, ¶¶[0065]-[0066]; EX-1006, 17:34-44. Mark explicitly

discloses “a configuration file” can be created to present “parameters... (e.g., layer thickness and/or bonded row width; variable feedrate for curves, bends, or outer/inner walls; bridging (printing unsupported spans) lengths for neat plastic or fiber; or limitations for printing spurs (single walled sections).” EX-1006, 11:33-65, 13:4-19, 17:53-58, FIG. 6. Mark also illustrates an example rule set/“parameter database” (“a *fabrication profile*”) including various rules and parameters (including “Material,” “Fiber Type”) in FIG. 20 (reproduced below). A POSITA would have recognized and found obvious that Mark’s rule set/parameter database (including e.g., “Material” “Fiber Type”) would have been created based on the one or more printer properties received from the target printer (e.g., the properties of the “Material” and the “Fiber Type” supported by the printer) as disclosed in Douglas.

Fig. 20

RULE/PARAMETER DATABASE

Toolpath N...M	Trajectory Definition	Material
Region N...M	Fill Density	Fill Pattern
Region N...M	Use Fiber (T)	Fiber Layers (3) Fiber Type (F, CAF) Concentric Rings (2)
Layer N...M	Pause After Layer (T)	
Layer N...M	Use Fiber (T)	Fiber Layers (3) Fiber Type (F, CAF) Concentric Rings (2)
Layer N...M	Fill Density	Fill Pattern
Global	Wall Layers (3, 2-5)	
Global	Roof & Floor Layers (4, 2-10)	
Global	Use Fiber (T)	Fiber Layers (3) Fiber Type (F, CAF) Concentric Rings (2)
Global	Use Supports (T)	Support (S, P)
Global	Fill Density	Fill Pattern

Example printer properties

A fabrication profile generated based on printer properties

EX-1006, FIG. 20.

58. As also shown and described with respect to FIGS. 5-7, 20, and 21 of Mark, these parameters in the rule sets 1006 or configuration file assist the Mark's slicer and path generator for "controlling path planning" in the generation of "G-code," which is also consistent with the '774 patent's description of the "fabrication profile." EX-1001, 23:58-67 (disclosing "The fabrication profile may include machine readable information for the slicer in creating a machine-ready model. The fabrication profile may be created using a library or the like and a resource or tool that parses the fabrication profile and obtains suitable inputs for a slicing engine or other program used to create machine-ready models. Thus the resource or tool may translate or interpret the dictionary into information for the slicer so that a suitable model can be created (or selected) for the target printer.").

59. Indeed, Mark describes that, when slicing a geometry file to determine a toolpath/G-code, characteristics of the capabilities of the printer are considered (e.g., material property and feedrate). EX-1006, 11:33-65, 13:4-19, 17:53-58, FIGS.5-7, 20 and 21. Accordingly, a POSITA would have recognized and found obvious to organize Douglas' operational parameters into a "profile" (e.g., in a more explicit form of a configuration file, a rule set or parameter database as taught by Mark) at least because organizing these parameters in such a data structure facilitates the use of these parameters for the generation of toolpaths/G-code, and provide better storage and computational efficiency, and allow easier rendering of such

operational parameters for user view in a user interface as shown in Marks' FIGS. 10 and FIGS. 20 and/or 21 (rule sets and data structures. EX-1005, ¶¶[0065]-[0066]; EX-1006, 11:33-65, 13:4-19, 17: 34-44, 53-58, FIGS. 5-7, 9-10, 21-22.

[1.6] generating a machine-ready representation of the three-dimensional model executable by the target printer to fabricate the object.

60. Douglas discloses “fabricating an object while using the operational parameter(s) to control operation of a three-dimensional printer.” EX-1005, ¶[0099], FIG. 6.

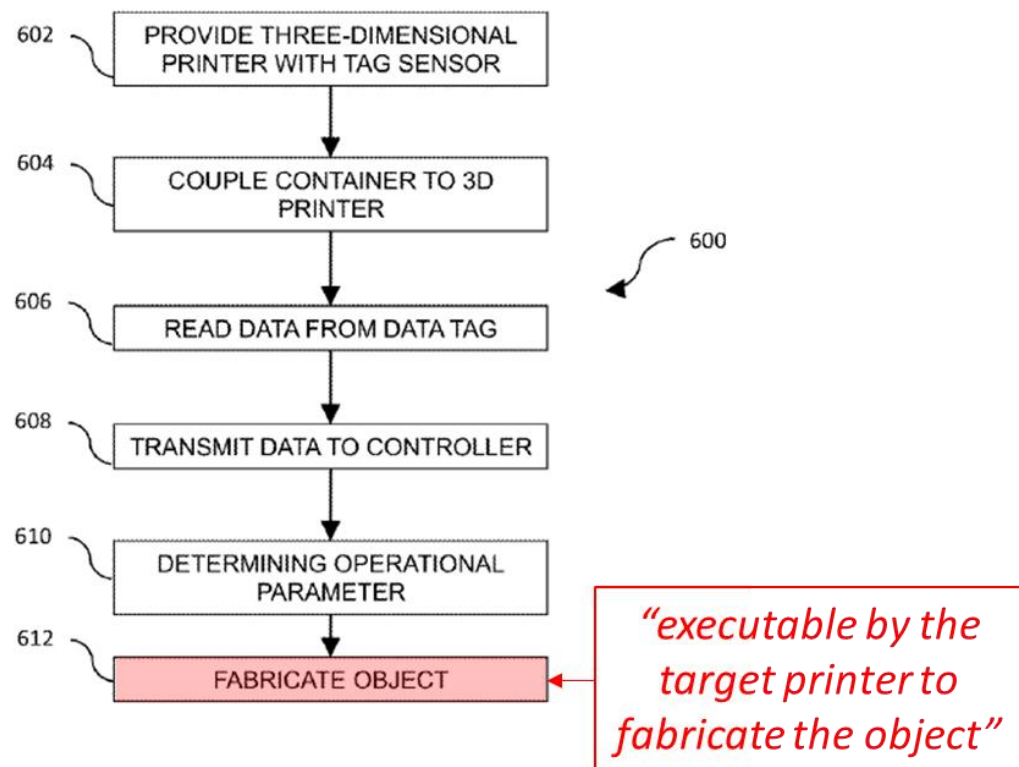


Fig. 6

EX-1005, FIG. 6.

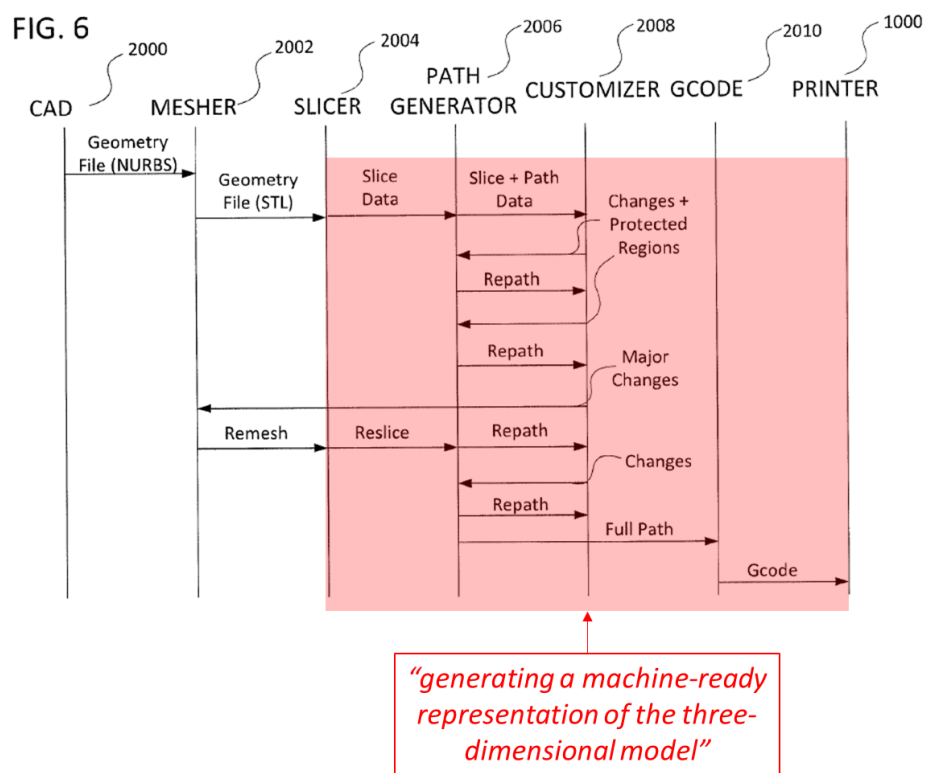
61. Douglas also discloses a “print queue” of the target printer that contains “print data (e.g., ...tool instructions to fabricate an object) for a number of print job.” EX-1005, ¶[0041]. A POSITA would have recognized and found obvious that the “tool instructions to fabricate an object” would have been “***a machine-ready representation of the three-dimensional model executable by the target printer to fabricate the object***” (and generated by a slicer and tool path generator as disclosed by Mark) because Douglas discloses that the “tool instructions” “which may be arranged for presentation in order of expected execution,” consistent with the ’774 patent’s characterization of the “machine-ready representation, [which] may be a machine-ready model of the three dimensional model of the object that is executable by a target printer to fabricate the object. EX-1005, ¶[0041]; EX-1001, 24:25-29.

62. Douglas discloses its printer server “maintain[s] print queues for participating three-dimensional printers,” and communicates with the 3D printers to allocate print jobs, for example, based the capabilities of the printers. EX-1005, ¶[0040]; *see also above* [1.2] (showing the “print server 208” can “automatically select one of the three-dimensional printers 204 for a user-submitted print job”). A POSITA would have recognized and found obvious that the “tool instructions to fabricate an object” in the print queues would have been generated by the printer server and sent to a selected printer for a print job because the printer server has a

global view of the properties of the individual printers and the determined operational parameters based on the properties of the target printer. EX-1005, ¶¶[0040]-[0041]; *see also above* [1.2]-[1.4].

63. To the extent it is argued that Douglas does not explicitly disclose implementation details of generating the tool instructions, a POSITA would have found it obvious in Douglas-Mark because Mark discloses “generating three-dimensional toolpath instructions for a three dimensional printer” using well-known, commonly used programs such as a slicer and/or toolpath generator that generate a “machine-specific code” (e.g., G-code). EX-1006, 11:33-65, 12:15-25 (disclosing “the tool generator generates toolpaths may also serve as the g-code generator by interpreting the toolpath into a machine-specific code.”), 13:4-19, 17:53-58, FIG. 6. As discussed above in [1.5] and Sections VIII.B and IX.A.1, Mark discloses “generating three-dimensional toolpath instructions” such as G-code based on the configuration parameters/rule sets (which corresponds to Douglas’ operational parameters) (“***generating a machine-ready representation of the three-dimensional model***”). EX-1005, ¶¶[0065]-[0066]; EX-1006, 11:33-65, 13:4-19, 17:53-58, FIG. 6; *see above*, [1.5]. The ’774 Patent acknowledges “g-code” as an example of such a “machine-ready representation.” EX-1001, 25:33-34. Mark explains that the “3D printer is controlled by a motion controller 20 which interprets dedicated G-code 1102 and drives various actuators of the 3D printer in accordance

with the G-code 1102,” thus fabricating the object (“***executable by the target printer to fabricate the object***”). EX-1006, 3:65-4:6, 12:15-25 (disclosing that G-code includes “all starting and finishing times, control or command variables (e.g., speed for a motor, current for a heater), and the like, to arrange the actuator instructions sufficient for a job to complete”), 12:49-61.



EX-1006, FIG. 6.

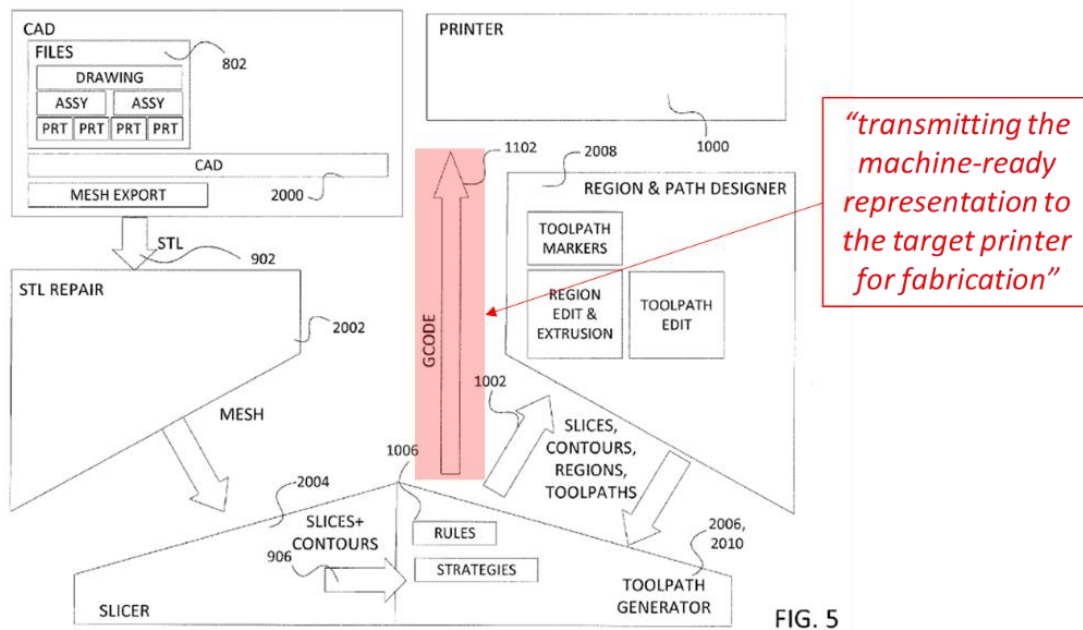
64. As discussed above, a POSITA would have recognized and found obvious that Douglas’ printer server would have generated the tool instructions (corresponding to Mark’s toolpath instructions such as G-code) (“***machine-ready representation of the three-dimensional model***”) using an appropriate slicing

program, such as Mark's slicer and/or path generator. EX-1005, ¶¶[0040]-[0041], [0065]-[0066], [0099], FIGS. 2, 6; EX-1006, 11:33-65, 13:4-19, 17:53-58, FIG. 6. The tool instructions/G-code would have been sent to the target printer to be executed to fabricate the object in the print job. *Id.*

[2] The method of claim 1 further comprising transmitting the machine-ready representation to the target printer for fabrication.

65. As discussed above in [1.6], a POSITA would have recognized and found obvious that that Douglas' printer server would have generated the tool instructions ("**the machine-ready representation**") and transmit them, for example, as part of the "print queue," to the selected printer to fabricate the print job. EX-1005, ¶¶[0040]-[0041], [0065]-[0066], [0099], FIGS. 2, 6.

66. Additionally or alternatively, Mark expressly discloses and shows that the G-code ("**the machine-ready representation**") is generated by a slicer and/or path generator and then "sent" to the 3D printer ("**transmitting to the target printer for fabrication**"). EX-1006, 12:15-25, FIG. 5. As discussed in [1.6], the tool instructions/G-code would have been sent to the target printer to be executed to fabricate the object in the print job. *See above*, [1.6].



EX-1006, FIG. 5.

67. Slicer applications are typically executed on a general purpose computer and the generated machine-ready code is transmitted to the 3D printer (either through a direct connection to a printer or over a network). EX-1011, 34-35 (describing a “Printer Control” application), 44 (“... the slicer application on your computer ...”). For example, as explained in Ground 2A below, Evans explains that, in addition to the slicer application, a printer control application typically “process[es] the G-code file” and “send[s] these commands to the 3D printer” (“**transmitting the machine-ready representation to the target printer for fabrication**”). EX-1011, 34-35, 46-52; *see below* §IX.E. As such, claim 2 is further obvious in view of the combination and knowledge of a POSITA.

[3] The method of claim 1 further comprising fabricating the object with the target printer.

68. As discussed above in [1.6], Douglas discloses fabricating objects using the selected printer (“***fabricating the object with the target printer***”). EX-1005, ¶¶[0041], [0065]-[0066], [0099]; *see also* EX-1006, 3:65-4:6, 11:33-65, 12:15-25, 12:49-61, 13:4-19, 17:53-58, FIG. 6.

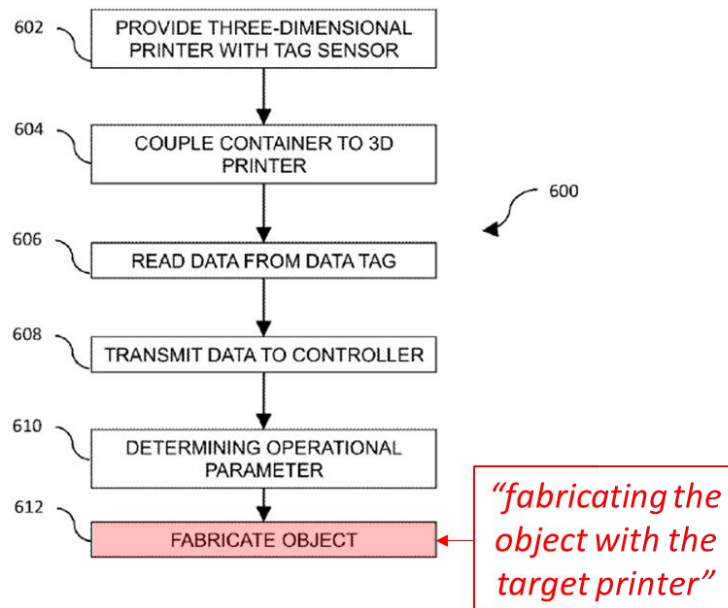


Fig. 6

EX-1005, FIG. 6.

[4] The method of claim 1 wherein the one or more properties include a hardware configuration of the target printer.

69. Claim 5 makes it clear that the claimed “hardware configuration” encompasses at least a “build material type.” EX-1001, claim 5. Douglas similarly discloses that the information in its data tag (“***the one or more***

properties”) includes at least one **hardware configuration of the target printer** such as “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, a build material expiration date, or other characteristic information appropriate for a three-dimensional printer.” EX-1006, ¶¶[0064], [0074].

[5] The method of claim 4 wherein the hardware configuration includes one or more of an extruder type, an extruder nozzle diameter, a build volume, a build platform type, a hardware version number, a top speed for linear movement of a tool, a step size for movement of the tool, a minimum z-axis size, a gantry type, and a build material type.

70. As discussed above in [4], Douglas’ data tag information includes at least “**a build material type.**” EX-1005, ¶¶[0064], [0074]; *see above*, [4].

[9] The method of claim 1 wherein the one or more properties include one or more user settings on the target printer.

71. Douglas discloses that the material in the printer is loaded by a user and a user can “order replacement material” with specific properties such as “a part number, build material type, or the like to assist the user in ordering a suitable replacement.” EX-1005, ¶¶[0077], [0099]. A POSITA would have recognized and found obvious that the data tag data related to material properties (e.g., “a build

material type”) would have been “**one or more user settings on the target printer**” because the material is chosen and installed into the printer by the user and the printer is set to reflect the material (e.g., by the printer reading the data tag) by the user installing the material in the printer. In fact, in many examples of print engine/slicer software (e.g. MakerBot Desktop), a user selection was part of the functionality of the software, and this selection is what triggered the printer to return any relevant settings to the software (e.g., a loaded material).

[10] The method of claim 9 wherein the one or more user settings include user setting from a previous fabrication process.

72. As discussed above in [9], Douglas discloses “a depletion of build material” can be detected and a user can order replacement material. EX-1005, ¶[0077]. A POSITA would have recognized and found obvious that **the** data tag data related to properties of material (e.g., “a build material type”) reused for subsequent of multiple builds would have been “**user setting from a previous fabrication process**” when the material selected/loaded by the user has not been depleted. *Id.*

[12] The method of claim 1 wherein the one or more properties include a build material in the target printer.

73. As discussed above in [4], Douglas’ data tag information includes “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, a build material expiration date, or other characteristic information appropriate for a three-dimensional printer (“**the one or more properties include a build material in the target printer**”). EX-1005, ¶¶[0064], [0074]; *see above*, [4].

[13] The method of claim 1 wherein generating the machine-ready representation includes processing the three-dimensional model according to the fabrication profile.

74. Mark discloses that, in generating G-code (“**generating the machine-ready representation**”), “a geometry file is ‘sliced’ by a family of slicer routines” (“**the three-dimensional model**” is processed) and then, for each slice, “toolpaths (‘layers and slices’ 1002) are calculated by a path planner 1004 for controlling actuators to deposit, focus a laser or lamp or projector to cure, solidify, or otherwise apply material.” EX-1006, 11:33-65, FIGS. 5-6, 10. As discussed above in [1.5], a collection of operational parameters as disclosed by Douglas alone or further in the form of a “configuration file,” or a rule/parameter database as disclosed by Mark, assists the slicer and/or path generator for “controlling path planning” in the generation of G-code (“**processing the three-dimensional model according to the fabrication profile**”). EX-1005, ¶¶[0065]-[0066], [0097]-[0099] (describing that operational parameters are determined based on data from the data

tag); EX-1006, 11:33-65, 13:4-19, 17:53-58, FIGS. 6-7, 9-10, 20-21; *see above*, [1.5].

75. For example, Mark discloses that the configuration file includes settings including “layer thickness,” “feedrate for curves, bends, or outer/inner walls,” “bridging (printing unsupported spans) lengths,” and limitations for printing “single walled sections,” all of which would have impacted the path the printhead traveled when depositing material during the printing process, and thus the toolpaths defined in G-code. EX-1006, 17:34-18:4, FIG. 20. Mark illustrates an example configuration file/rule sets including various rules and parameters (e.g., “Material” “Fiber Type”) in FIG. 20, reproduced below. The rule sets were used for “control path planning” and “the part are created and changed by process control according to rule sets, i.e., the slice, contour, subcontour (region) and path generator and planners.”

Fig. 20 RULE/PARAMETER DATABASE

Toolpath N...M	Trajectory Definition		Material		
Region N...M	Fill Density		Fill Pattern		
Region N...M	Use Fiber (T)	Fiber Layers (3)	Fiber Type (F, CAF)	Concentric Rings (2)	
Layer N...M	Pause After Layer (T)				
Layer N...M	Use Fiber (T)	Fiber Layers (3)	Fiber Type (F, CAF)	Concentric Rings (2)	
Layer N...M	Fill Density		Fill Pattern		
Global	Wall Layers (3, 2-5)				
Global	Roof & Floor Layers (4, 2-10)				
Global	Use Fiber (T)	Fiber Layers (3)	Fiber Type (F, CAF)	Concentric Rings (2)	
Global	Use Supports (T)		Support (S, P)		
Global	Fill Density		Fill Pattern		

Mark's configuration files include various rules and parameters that define the generation of toolpaths and G-code

EX-1006, FIG. 20.

76. Further, Mark discloses that “[t]he G-code 1002 file... is dependent upon physical arrangement of the printer itself,” and a POSITA would have thus recognized and found obvious that G-code must be generated based on the limitations and capabilities of the printer (as represented in Douglas’ operational parameters and Mark’s configuration file that includes configuration parameters or rule/parameter database), and the generation of the G-code would have ***included processing the three-dimensional model according to the fabrication profile*** that includes the limitations and capabilities of the printer. EX-1006, 12:23-25. This information is necessary in the G-code because otherwise, there would be the possibility of the G-code not being compatible with the printer, for instance the

build volume. *Id.* For example, Mark describes that G-code is “machine-specific.” *Id.*

[20] The method of claim 1, wherein determining a target printer to fabricate the object comprises determining a geographic location of the target printer.

77. Douglas discloses that, “[w]here the print server 208 selects the printer automatically” (“**determining a target printer**”), the printer server determines criteria “such as geographical proximity...of a particular three-dimensional printer 204” (“**determining a geographic location of the target printer**”). EX-1005, ¶[0032]. The printer server can also “determine a location of the mobile device 212 initiating the print job and locate a closest printer for fabrication of the object,” and further that “a printing function may be location-based, using ... GPS input” (“**determining a geographic location of the target printer**”). EX-1005, ¶¶[0032], [0046]-[0047]. Moreover, Douglas discloses that, in **determining a target printer** “in the event of a failure by the one of the plurality of three-dimensional printers 204,” the print server 208 can determine, based on the “store[d] location of a predetermined alternative three-dimensional printer to execute a print job.” EX-1005, ¶[0038].

B. GROUND 1B—Douglas in view of Mark and Dahlin renders claims 6-7 and 9-10 obvious

1. A POSITA would have combined Douglas, Mark, and Dahlin

78. It would have been obvious for a POSITA to combine the teachings of Douglas-Mark and Dahlin to include Dahlin's techniques of querying material type and amount at the outset of a print job, for example, to ensure the appropriate and sufficient material to complete a print job. EX-1005, ¶¶[0023]-[0024], [0063]-[0064], [0074], [0077]; EX-1008, ¶¶[0022]-[0023]. A POSITA would have been motivated to combine Douglas-Mark and Dahlin for at least the following reasons.

79. First, Dahlin's techniques provide the assurance that the selected printer has enough material to complete the print job, something that is just as important as whether the printer has the correct materials. EX-1008, ¶¶[0022]-[0023]. This would have improved the user experience with the Douglas-Mark system, as it would prevent a user from having to resubmit a print job after the first job failed to complete. *Id.* Although Douglas' data tag data includes many parameters about the loaded material, Douglas does not explicitly disclose querying the material amount before at the outset of a job. *Id.* Additionally, querying the material type after a reload would have provided an opportunity to alert the user if an incorrect material was loaded. *Id.* To the extent it is argued a POSITA would not have found it obvious to query a material amount, Dahlin's techniques

would have ensured that the selected target printer could complete the print. EX-1008, ¶¶[0022]-[0023]; EX-1005, ¶¶[0063]-[0064], [0074], [0077].

80. Second, Dahlin’s techniques would have improved the print quality and prevented the Douglas-Mark system from printing defects resulting from a different reloaded material type from the depleted material type and wasting materials by starting print jobs that could not be finished due to a lack of material. EX-1008, ¶¶[0022]-[0023]. For example, Dahlin checks the adequacy of the loaded materials “at the outset of a job,” which would have prevent the printer from starting a print it could not finish. *Id.* Starting a print in a remote system, like Douglas-Mark, without adequate materials would have either (1) required operator intervention to reload filament in the remote printer, adding to the total time between job submission and completion, or (2) required the user to resubmit their print job to another printer. *Id.* Querying a material amount at the outset of the job, as suggested by Dahlin, would have improved the user experience at least by ensuring the above two scenarios are properly considered and addressed in the Douglas-Mark system. *Id.*

81. Douglas, Mark, and Dahlin are analogous art to the ’774 patent, which is generally directed to “the use of configuration information for a three-dimensional printer to select suitable machine-ready models.” EX-1001, 1:15-20. Douglas is generally related to “three-dimensional printers using fused deposition modeling or

similar techniques,” Mark is generally related to “three dimensional printing,” and Dahlin is generally related to “three-dimensional prototype modeling.” EX-1005, ¶¶[0012]-[0015], FIG. 1; EX-1006, 1:25; EX-1008, ¶¶[0001]-[0002]. Accordingly, the prior art references are all directed to the same field of 3D printing. *Id.*

82. Additionally, as explained below in more detail, combining Douglas-Mark and Dahlin would have been obvious at least because such a combination would have merely involved (1) combining prior art elements according to known methods to yield predictable results; and the (2) use of known technique to improve similar methods in the same way.

83. Incorporating Dahlin’s teachings into Douglas would have been predictable and foreseeable with a reasonable expectation of success because Douglas discloses that a “variety of additional sensors and other components may be usefully incorporated” into its printer, and Douglas specifically gives the example of “an optical detector” to “detect a presence of the object” (e.g., the Dahlin filament sensor, which “indicates the presence or absence of filament at the entrance to the filament feed tube”). EX-1005, ¶¶[0023]-[0024]; EX-1008, ¶[0022]. Additionally, Douglas explicitly discloses that its data tag can be used to determine “a depletion of build material.” EX-1005, ¶¶[0063], [0077]. A POSITA would have understood or found obvious that Douglas’ system already includes or envisions the hardware (e.g., the sensor) for detecting material type and amount as disclosed by Dahlin. A

POSITA would have an understanding of what could be done in software to query the material amount before at the outset of a job and include the information into Douglas' data tag data for transmission, as disclosed by Dahlin, and could implement the combination by instructing and further working with programmers to code it, if needed. With the predictable and foreseeable hardware and software implementations, the Douglas-Mark and Dahlin would have been reasonably successful.

2. Analysis

[6] The method of claim 4 wherein the hardware configuration includes an automatically detected hardware reconfiguration.

84. As an initial matter, the '774 patent describes the “**hardware reconfiguration**” includes “a new or replacement component on their printer.” EX-1001, 19:46-55.

85. Both Douglas and Dahlin disclose that when materials are inadequate (e.g., a spool of filament) a user can be notified to replace the materials. EX-1005, ¶¶[0063], [0077]; EX-1008, ¶¶[0022]-[0023]. Dahlin further discloses that when materials are reloaded, a “filament sensor” can detect whether “the modeling filament material on the spool is the same material specified in object data” (“**an automatically detected hardware reconfiguration**”). *Id.* Dahlin also discloses “the type of filament that is on the

spool” is transmitted to the “the control system 90” so that “the CPU keeps track of how much material was commanded to be extruded,” etc. EX-1008, ¶[0022]. It would have been obvious to a POSITA that, in the Douglas-Mark-Dahlin combination, the data tag data received from the printer would have included the automatically detected new or replacement material loaded on the spool because it is critical information reflects the current fabrication capability of the printer and is explicitly identified by Douglas (i.e., “a build material type”) as an example of a **hardware configuration of the target printer** as discussed in [4] above. EX-1008, ¶¶[0022]-[0023]; EX-1005, ¶¶[0064], [0074].

[7] The method of claim 4 wherein the hardware configuration includes a manually specified hardware reconfiguration.

86. As discussed in [6] above, Dahlin discloses that when materials are inadequate (e.g., a spool of filament) a user can be notified to replace the materials (materials chosen and loaded by the user—“**a manually specified hardware reconfiguration**”). EX-1008, ¶¶[0022]-[0023]. It would have been obvious to a POSITA that, in the Douglas-Mark-Dahlin combination, the data tag data received from the printer would have included the **manually specified** new or replacement material loaded by the user on the spool because it is critical information related to the current fabrication capability of the printer and is explicitly identified by Douglas (i.e., “a build material type”) as an example of a

hardware configuration of the target printer as discussed in [4] above. *Id.*; see above, [4].

[9] The method of claim 1 wherein the one or more properties include one or more user settings on the target printer.

87. As discussed above in [6]-[7], a user loads the type of material in the printer, which is “**one or more user settings on the target printer**” (e.g., a type of material the user has loaded) and would have been included in the data tag data received from the printer and is explicitly identified by Douglas (i.e., “a build material type”) as an example of the **one or more properties**. EX-1008, ¶¶[0022]-[0023]; see above, [6]-[7].

[10] The method of claim 9 wherein the one or more user settings include user setting from a previous fabrication process.

88. Dahlin discloses that at the beginning of a print job, the printer’s processor will “calculate whether a spool ... contains enough filament to complete the job,” suggesting that filament loaded by a user can be used across multiple print jobs (“**fabrication process[es]**”). EX-1008, ¶¶[0022]-[0023]. A POSITA would have recognized and found obvious that, in at least some occasions, the same user selected material would have been maintained across print jobs and the material properties (e.g., at least the type of a user installed filament) used in a previous print jobs would have been used in a current or future print job, for example, as discussed in Evans, or when printing multiple parts of

the same material in an assembly as disclosed in Hamilton), thus ***the one or more user settings*** as disclosed in [9] is also a ***user setting from a previous fabrication process***. EX-1008, ¶¶[0022]-[0023]. For example, Evans discloses that a user can set some print settings, “try another model using the same steps and settings,” “and forget about them,” such that these settings would have been used for multiple print jobs (“***the one or more user settings include user setting from a previous fabrication process***”). EX-1011, 62-70. Similarly, Evans discloses that after “Choosing the right Material,” and “Buying Filament,” together with a spindle holder, “you will never need to worry about your filament again” such that the material properties would include the filament chosen by the user from a previous fabrication process (“***the one or more user settings include user setting from a previous fabrication process***”). EX-1011, 26-27. Occasionally a complex structure will need to be printed in separate parts (as Hamilton describes). EX-1010, ¶¶[0022]-[0023]. In the case where the parts of the assembly is comprised of only one type of material, it would have been efficient to maintain printer settings across the fabrication of each similar component. *Id.*

C. GROUNDS 1C—Douglas in view of Mark and Batchelder renders claim 8 obvious

1. A POSITA would have combined Douglas, Mark, and Batchelder

89. It would have been obvious for a POSITA to combine the teachings of

Douglas-Mark and Batchelder to incorporate software and firmware information of a 3D printer into printer properties transmitted by the printer to the printer sever for a print job for at least the following reasons.

90. First, it was known to a POSITA that firmware was a vital component of the 3D printer. EX-1007, ¶¶[0043], [0054]. Evans corroborates the importance of printer firmware and explains the “printer control ... communicates with a specialized set of code called firmware” that “controls the electronics hardware to build our 3D objects according to the instructions received from the printer control,” and further, describes that “[h]ow well firmware [interprets G-code] will determine how well your 3D printer will print objects.” EX-1011, 35, 41, 76-80. Based on the importance of firmware in affecting the fabrication capability of the printer, a POSITA would have been motivated to include the firmware configuration into the information transmitted by the printer (e.g., Douglas’ data tag information) to assist the printer server in determining a suitable target printer and generating operational parameters (which are dependent on a printer’s firmware version). EX-1007, ¶¶[0043], [0054]; EX-1005, ¶¶[0032], [0072]-[0075], [0094]-[0097]. As Evans notes, the printer’s firmware is critical to the operation of the printer, and would have directly impacted the generation of operation parameters because firmware controls how a printer would interpret received commands. EX-1011, 35, 41, 76-80. The reliance on the firmware configuration of the selected printer to fabricate with the

applicable type of build material further suggests the need for obtaining the printer's firmware configuration from the target printer.

91. Second, incorporating the firmware configuration (e.g., the current version or update) into Douglas-Mark system would have improved the quality of resulting prints because, with the knowledge of the firmware configuration, a more compatible G-code can be generated based on the user's printers control applications. This was important because firmware updates were frequent, as printing hardware and software was changing rapidly before the Critical Date of the '774 patent. Desktop printer software regularly prompted firmware updates to increase the fidelity of the G-code instructions for a given configuration. The software kept track of the firmware configuration through communication with the printer. This ensured the optimal result for printing and the most error-free communication between the software version of the desktop printer software and the printer through accurate G-code file generation.

92. Third, incorporating the firmware configuration (e.g., the current version or update) into Douglas-Mark system would have improved user experience, e.g., by avoiding re-submitting of a failed or less satisfied print result resulted from incompatible. For example, verifying a printer firmware configuration at the outset of a job would prevent a user from having to resubmit a print job after the first job failed to complete because the generated G-code was incompatible with

the printer's firmware or the printer firmware out of date. EX-1007, ¶¶[0052]-[0054], FIG. 2; EX-1005, ¶¶[0064], [0074].

93. Douglas, Mark, and Batchelder are analogous art to the '774 patent, which is generally directed to "the use of configuration information for a three-dimensional printer to select suitable machine-ready models." EX-1001, 1:15-20. Douglas is generally related to "three-dimensional printers using fused deposition modeling or similar techniques," Mark is generally related to "three dimensional printing," and Batchelder is generally related to "additive manufacturing systems for building three-dimensional (3D) models." EX-1005, ¶¶[0012]-[0015], FIG. 1; EX-1006, 1:25; EX-1008, ¶¶[0004]-[0010]. Accordingly, the prior art references are all directed to the same field of 3D printing. *Id.*

94. Additionally, as explained below in more detail, combining Douglas-Mark and Batchelder would have been obvious at least because such a combination would have merely involved (1) combining prior art elements according to known methods to yield predictable results; and the (2) use of known technique to improve similar methods in the same way.

95. Incorporating Batchelder's teachings into Douglas-Mark would have been predictable and foreseeable with a reasonable expectation of success because Douglas already discloses a printer sending various printer configuration information to the printer server, and including another critical, useful and beneficial

information such as firmware information for generating the machine-ready models would have been well within a POSITA's capability. EX-1005, ¶¶[0023]-[0024]; EX-1007, ¶¶[0052]-[0058]. For example, the firmware information can be marked in the material as suggested by Batchelder, and Douglas can modify its "tag sensor" and/or a "variety of additional sensors and other components may be usefully incorporated" into its printer in a similar manner as Batchelder's sensor assembly, which reads the firmware configuration, and then transmit the firmware configuration information (e.g., as part of the tag data) to the printer server to help "determining an operational parameter for the fabrication of an object by the three-dimensional printer." EX-1005, ¶¶[0023]-[0024], [0062]-[0064], [0078]-[0083], [0091]-[0097], FIG. 6; EX-1007, ¶¶[0052]-[0058]. A POSITA would have an understanding of what could be done in software to include the firmware information into Douglas' data tag data for transmission and could implement the combination by instructing and further working with programmers to code it, if needed, with a reasonable expectation of success.

2. Analysis

[8] The method of claim 1 wherein the one or more properties include a firmware configuration of the target printer.

96. Batchelder explicitly discloses "firmware updates for the system" ("***a firmware configuration of the target printer***") as an example property that

“assist[s] in building 3D model” (“*properties ... that affect fabrication capabilities of the target printer*”). EX-1007, ¶¶[0052]-[0054], FIG. 2. As discussed above, a POSITA would have found it obvious to include the *firmware configuration of the target printer* in the printer properties transmitted from the printer to the printer server in Douglas-Mark system to facilitate the printing job because the important role that the firmware configuration in affecting fabrication capabilities of the target printer.

D. GROUND 1D—Douglas in view of Mark and Pax renders claim 19 obvious

1. A POSITA would have combined Douglas, Mark, and Pax

97. A POSITA would have been motivated to implement Douglas-Mark’s system to employ Pax’s suggestion of generating descriptive metadata specifying properties for “a pre-fabrication check” for multiple reasons. EX-1013, ¶¶[0096]-[00101], FIG. 11.

98. For example, Douglas discloses that a “print queue” of a printer includes “tool instructions” for the print jobs and accompanying “metadata concerning print jobs.” EX-1005, ¶[0041]. Pax provides specific examples of information that are included in the metadata, such as, “the color and material requirements,” which can be used for “pre-fabrication check” to ensure “the color and material require[d]” by the “tool instructions to fabricate an object model” in the

print job are met by “the available build materials” of the selected printer. EX-1005, ¶[0041]; EX-1013, ¶¶[0096]-[0099], FIG.11. A POSITA would have been motivated to apply Pax’s suggestion of metadata that specifies properties useful for “a pre-fabrication check” in Douglas-Mark’s metadata in the print queue so a printer receives the tool instructions and the metadata in the print queue, and performs a check before fabrication to prevent “print errors, waste.” *Id.* A pre-fabrication check also would have reduced the amount of time the user would have needed to spend troubleshooting, also improving the user experience. *Id.*

99. Douglas, Mark, and Pax are analogous art to the ’774 patent, which is generally directed to “the use of configuration information for a three-dimensional printer to select suitable machine-ready models.” EX-1001, 1:15-20. Douglas is generally related to “three-dimensional printers using fused deposition modeling or similar techniques,” Mark is generally related to “three dimensional printing,” and Pax is generally directed to “three-dimensional printers using fused deposition modeling or similar techniques.” EX-1005, ¶¶[0012]-[0015], FIG. 1; EX-1006, 1:25; EX-1013, ¶¶[0003]-[0010], [0028]-[0029], FIG. 1. Accordingly, the prior art references are all directed to the same field of 3D printing. *Id.*

100. Additionally, as explained below in more detail, combining Douglas-Mark and Pax would have been obvious at least because such a combination would have merely involved (1) combining prior art elements (e.g., descriptive metadata

including useful properties to accompany machine-ready instructions/g-code) according to known methods to yield predictable results; and the (2) use of known technique (e.g., pre-fabrication check by comparing properties) to improve similar methods in the same way.

101. Incorporating Pax's teachings into Douglas-Mark would have been predictable and foreseeable with a reasonable expectation of success because Douglas already discloses that "metadata" can include "recommended printer settings," EX-1005, ¶[0037]. Further, metadata generation is a well-known and commonly used feature in the software of 3D printing (e.g., slicer) that would have been predictably implemented with reasonable expectation of success. EX-1013, ¶[0095]; EX-1011, 34, 61-62. A POSITA would have an understanding of what could be done in hardware (e.g., a sensor) and software (e.g., generating metadata) to incorporate Pax's teachings into Douglas-Mark combination, and could have done so by instructing and further working with programmers to code the software part if needed. With the predictable and foreseeable hardware and software implementations, the Douglas-Mark-Pax combination would have been reasonably successful.

2. Analysis

[19] The method of claim 1 further comprising generating descriptive metadata to accompany the machine-ready representation, the descriptive metadata specifying one or more properties for comparison to properties of printers selected for fabricating the model.

102. Douglas discloses its generated “print queue” includes “metadata concerning print jobs” **accompanying** “print data” that includes “(e.g., the three-dimensional model or tool instructions to fabricate an object)” (“**machine-ready representation**”). EX-1005, ¶¶[0040]-[0041].

103. Pax also discloses “metadata” (“**descriptive metadata**”) that specifies “color and material requirements for fabricating the object” (“**one or more properties**”) for a “pre-fabrication check [that] compare[s] the color and material requirements to the available build materials” of a selected printer (“**one or more properties for comparison to properties of printers selected for fabricating the model**”). EX-1013, ¶¶[0096]-[0099], FIG. 11. Pax discloses that “the requirements [are] contained in metadata of the object model, fabrication instructions, or a related file,” further corroborating that the metadata are generated to accompany “fabrication instructions,” such as (“gcode”) (“**the machine-ready representation**”). EX-1013, ¶[0097].

104. A POSITA would have also recognized and found obvious that the Douglas-Mark-Pax metadata would have “**accompan[ied] the machine-ready**

representation” because it is used for “pre-fabrication check” before the printer uses “fabrication instructions” (“***the machine-ready representation***”) to fabricate the object and as this was typical in the art before the Critical Date. EX-1013, ¶¶[0097]-[0104], FIG. 11; EX-1009, ¶¶[0008], [0062]-[0063], FIG. 3.

105. As shown in FIG. 11, Pax suggests a printer performs process 1100, “a process for fabricating an object,” which includes the “pre-fabrication check” in step 1108 and fabricating “the component, e.g., single-color portion, of the model” in step 1114. EX-1013, ¶¶[0023], [0096]-[0099], FIG. 11. A POSITA also would have recognized and found obvious that the 3D printer would have performed the pre-fabrication check, at least because this would have prevented improperly generated G-code from damaging the printer and to reduce or prevent “print errors, waste, or other process variations.” EX-1013, ¶¶[0096]-[0099]. Although Douglas and Mark describe techniques for determining printer capabilities prior to generating G-code, 3D printing equipment can be sensitive and expensive, and therefore, it is prudent to have the printer locally verify the suitability of instructions prior to commencing a print, rather than implicitly trusting any received code. *Id.* One example technique of printers verifying G-code prior to execution was the “look-ahead” function in printer firmware that would examine instructions prior to execution in order to improve print quality (e.g., anticipating the next movement command to minimize unnecessary stopping). EX-1011, 41-42. Marlin firmware was one of the first

examples of local printer firmware that checked G-code instructions prior to execution in this way. *Id.* Firmware features that check G-code at the printer, like look-ahead, act as a final line of defense against bad code (e.g., trying to print a part with the wrong material, or execute a movement that exceeds a printer's capability).

Id.

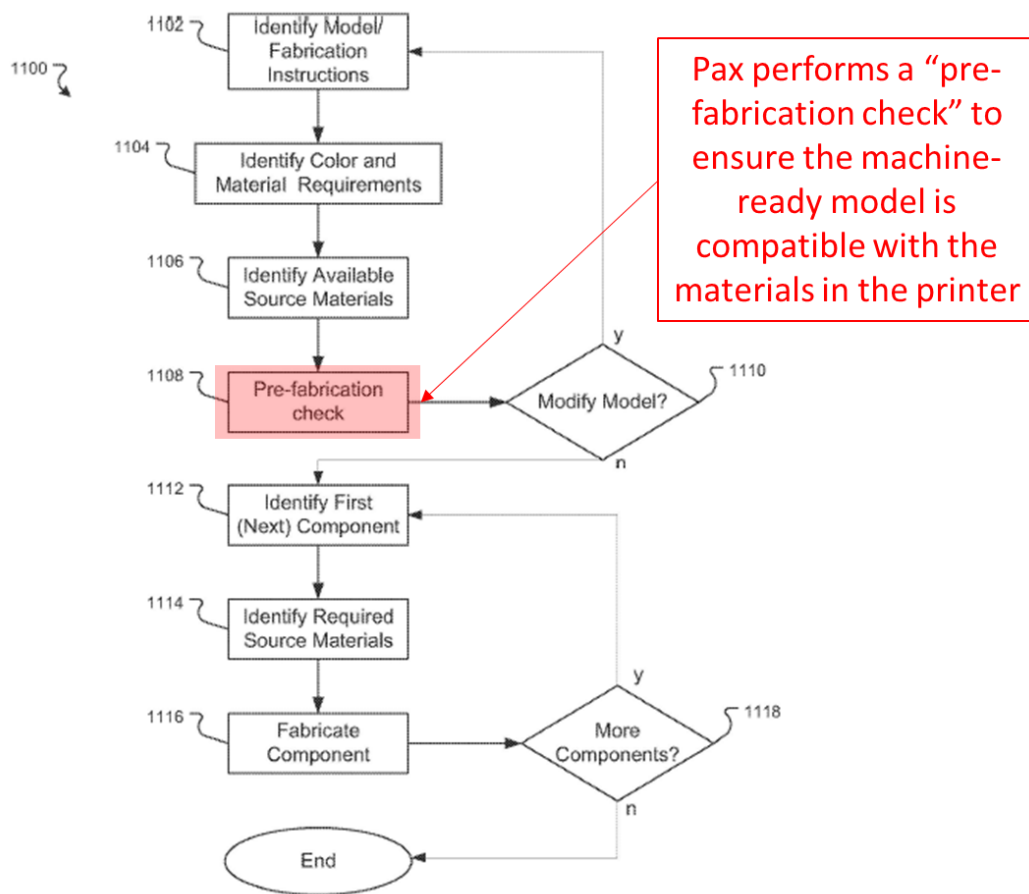


FIG. 11

EX-1013, FIG. 11.

E. GROUND 2A—Hamilton in view of Evans, with or without KISSlicer, renders claims 1-5, 9-10, 12-13 obvious

1. A POSITA would have combined Hamilton and Evans

106. A POSITA would have been motivated to implement Hamilton’s system in a manner that employs Evans’ explicit teaching of a slicer configured to process (e.g., slice) a 3D model into layers and generate toolpath instructions (e.g., G-code) according to a configuration profile created based on properties that reflect the fabrication capability of the 3D printer and used for the generation of the G-code, and configured to transmit the G-code to the 3D printer for execution, includes Evans’ additional examples of printer and filament properties (including user settings on the printer) in the “printer accuracy and capabilities” transmitted from the printer for the selection of a suitable printer to fabricate an object, and Evans’ explicit teaching on user’s selection and replacement of material in the 3D printer. *See e.g.*, EX-1010, ¶¶[0016]-[0019], [0021], FIG. 3; EX-1011, 25-28, 43-46, 62. A POSITA would have been motivated to combine Hamilton and Evans for at least the following reasons.

107. First, Hamilton discloses constructing/fabricating a product using a 3D printer with a focus on querying and checking the printer’s capabilities for a specific design/fabrication job, without detailing how the 3D printer fabricates the design. EX-1010, ¶¶[0016]-[0019], [0021], FIG. 3. Evans provides implementation details

for Hamilton's system. For example, Evans provides a comprehensive overview of a "3D printer toolchain" which describes a detailed process of converting a 3D model into a physical object. EX-1011, 33-53. Specifically, Evans describes how a "slicer" can be used to process a 3D model into machine-ready code (e.g., "G-code"). EX-1011, 43-46. Evans discloses a slicer application (e.g., "Slic3r") "calculates" the configurations for generating toolpaths upon receiving "only a few parameters about your printer, [and] the filament" (e.g., "filament diameter," "extruder nozzle size," "layer height," and "print speed"). EX-1011, 44-46. The slicer application provides a user interface that allows saving the configurations and uses the configuration to generate G-code. EX-1011, 45-47. Further, Evans describes "printer control" applications, where a user "can connect to [the] printer and talk to its firmware, move the three different axes, read and set the temperature for the hot end and the printbed, launch [the] slicer application, and print ... 3D models." EX-1011, 46-53. A POSITA trying to understand and implement Hamilton's system would have been motivated to look into Evans, the tutorial or "how-to manual" for 3D printing, for implementation details on "how 3D printers work." EX-1010, ¶¶[0016]-[0019], [0021], FIG. 3; EX-1011, 5, 33-53. In view of Evans, a POSITA would have understood that (1) Hamilton's 3D printer system would have included a slicer that slices an 3D object into layers and generates toolpaths/machine-ready code to control the printer to fabricate the object

accordingly, and (2) a collection of 3D printer settings/configurations would have been created for the slicer to generate the machine-ready code based on the properties of the printer such that the printer can fabricate the design properly. EX-1010, ¶¶[0016]-[0019], [0021], FIG. 3; EX-1011, 43-46, 62.

108. Second, specifically with respect to a slicer, Evans discloses that certain slicers (e.g., “Slic3r”) simplify the generation of machine-ready code by automatically calculating printer settings/configurations for generating toolpaths and the configurations can be saved, which provides advantages such as “ease of use, blistering slicing times, and remarkable print quality.” EX-1011, 33-34, 45-46. For example, Evans describes that “[w]here Skeinforge asks users to make a lot of calculations regarding the filament extrusion, Slic3r calculates all of these values under the hood after inputting only a few parameters about your printer, the filament, and the desired print settings.” EX-1011, 44-46. Further, a POSITA would have recognized and found obvious to create and save the configurations into a profile to provide better user experience and print efficiency, a feature already provided by many slicer applications by the Critical Date, such that the user does not need to specify every parameter every time a new print is requested, and the saved configurations can be “loaded,” and reused/revised for future prints. EX-1011, 34.

109. Third, Evans discloses that printer properties include numerous “print settings” that a user can select or alter (including filament material) to

change the quality of their prints, which a POSITA would have been motivated to include these properties in Hamilton's "accuracy and material capabilities" sent from the target printer to improve the capability and quality of the fabrication in Hamilton's system. EX-1010, ¶¶[0019]-[0021]; EX-1011, 62-70.

110. Fourth, Evans provides implementation details on selecting, loading, changing, and replacing material in a 3D printer." EX-1011, 26-28, 299-300. For example, when replacing printer filament, the user should "measure the diameter of your new filament and adjust your slicer settings accordingly before you make that first print." *Id.* A POSITA would have found it obvious that these techniques would have ensured that the Hamilton printer to have consistent or improved accuracy across multiple print jobs of user selected materials.

111. Hamilton and Evans are analogous art to the '774 patent, which is generally directed to "the use of configuration information for a three-dimensional printer to select suitable machine-ready models." EX-1001, 1:15-20. Hamilton generally describes a "product delivery system operable to deliver a virtual product which is manufactured locally using a 3D printer," and Evans is a "how-to-manual" for 3D printing. EX-1010, Abstract, ¶¶[0004]-[0006]; EX-1011, 4-6. Accordingly, the prior art references are all directed to the same field of 3D printing. *Id.*

112. Additionally, as explained below in more detail, combining Hamilton and Evans would have been obvious at least because such a combination would have

merely involved (1) combining prior art elements according to known methods to yield predictable results; and the (2) use of known technique to improve similar methods in the same way.

113. Incorporating Evans' teachings into Hamilton would have been predictable and foreseeable with a reasonable expectation of success because, as Evans notes, using slicing applications to generate machine-ready code (e.g., "G-code") has "been around for a while." EX-1011, 34. Slicers such as Slic3r and KISSlicer were well known and commonly used before the Critical Date. EX-1012, 3-4; EX-1015. In fact, most early print engine software was generated by slicer routines and was not coded by hand. Early adopters of 3D printing nearly all used slicing software instead of hand-coding machine-ready instructions. It would have been within the knowledge and skill of a POSITA to, for example, acquire and install a slicing application such as described by Evans to complete Hamilton's print request. Additionally, selecting, loading, changing and replacing filament materials are also routine operations of a user of a 3D printer. To the extent that the combination involves any sophisticated coding or programming skill, a POSITA would have an understanding of what could be done in software and could implement the combination by instructing and further working with programmers to code it, if needed, with a reasonable expectation of success.

2. A POSITA would have combined Hamilton, Evans, and KISSlicer³

114. It would have been obvious in Hamilton-Evans for the settings/configurations created based on printer properties to be a “profile,” in view of KISSlicer. EX-1012, 1-9. A POSITA would have found it obvious to simply implement the settings/configurations of Evans as a “profile” as disclosed by KISSlicer for a better user experience in that “you can save as many profiles as you like” and “you can rename the printer profile, create a new one and set some of the parameters,” as well as flexibility and efficiency of selecting from different preset profiles, as explicitly disclosed in KISSlicer. EX-1012, 3, 4, 8. The implementation of KISSlicer’s teachings into Hamilton-Evans system would have been predictable and well within a POSITA’s capability (e.g., referring to the setting/configurations as a profile) and indeed was common practice before the Critical Date.

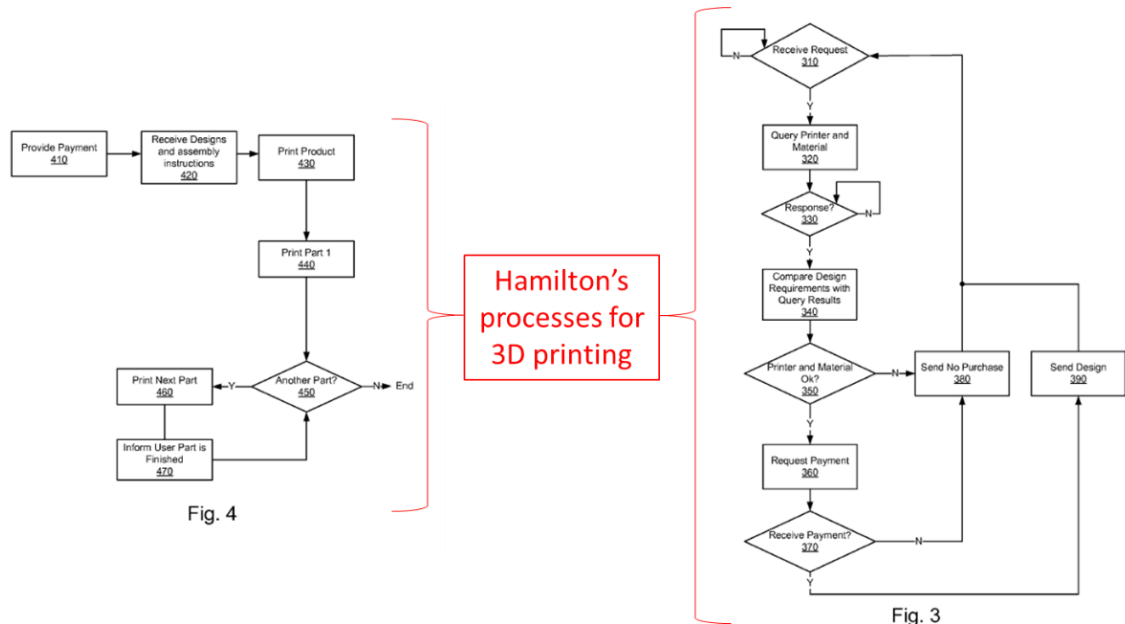
3. Analysis

[1.pre] A method comprising:

115. Hamilton discloses “[a] product delivery system operable to deliver a

³ KISSlicer is also optionally included in all subsequent Hamilton-Evans-based combinations below. The predictable implementation of KISSlicer’s “profile” into Hamilton-Evans system does not disturb mapping of Hamilton-Evans-based combinations to other claim elements.

virtual product which is manufactured locally using a 3D printer, and methods for using such (“*a method*”). EX-1010, Abstract, ¶¶[0021]-[0022], FIGS. 3-4. Illustrated below are examples of Hamilton’s techniques, embodied as a “process” (“*a method*”). EX-1010, FIG. 3-4.



EX-1010, FIGS. 3-4.

[1.1] receiving a request to fabricate an object from a three-dimensional model;

116. Hamilton discloses that its process of fabricating an object at a design supplier begins with “a request for a design” that includes a design of the object to be printed (“*a request to fabricate an object*”). EX-1010, ¶¶[0015]-[0022], FIGS. 3-4. This step is illustrated below in Hamilton’s FIGS. 3 and 4 processes.

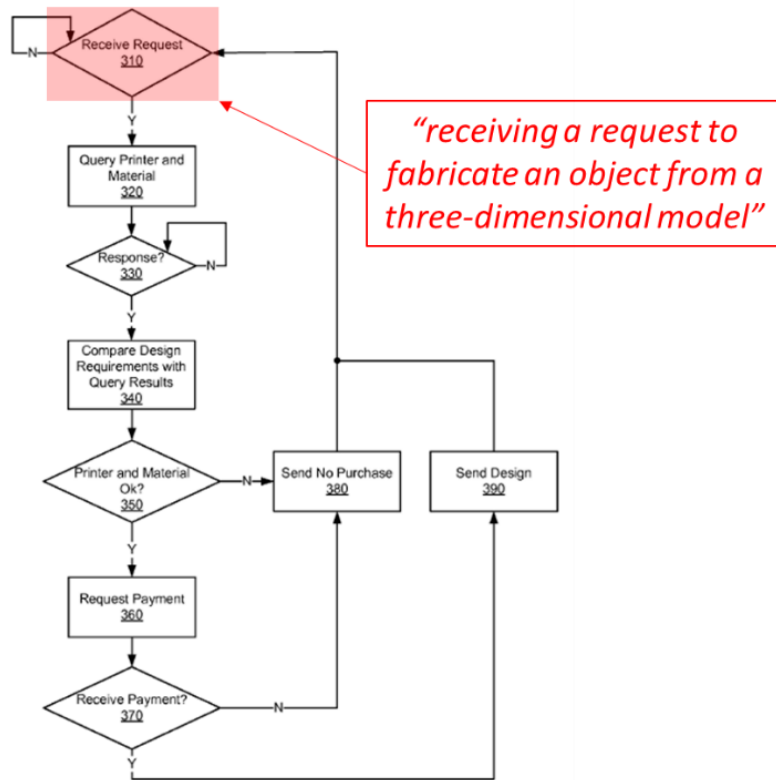


Fig. 3

EX-1010, FIG. 3.

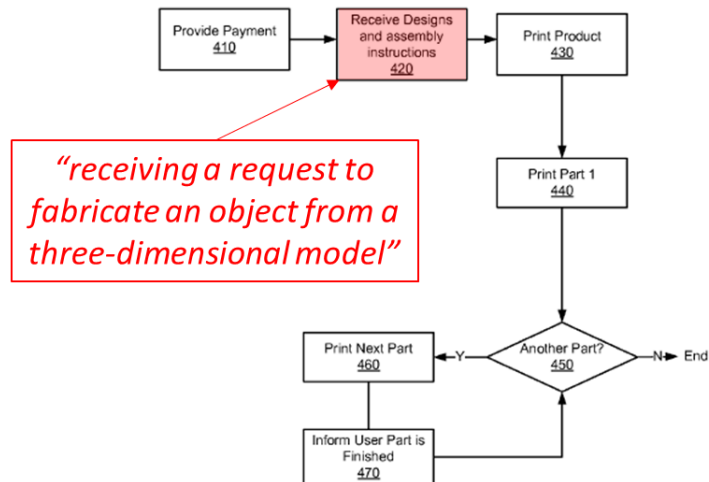


Fig. 4

EX-1010, FIG. 4.

117. Additionally, given that Hamilton's system fabricates objects using a 3D printer "operable to print given designs" and "to produce a product corresponding to the product construction specification," a POSITA would have recognized and found obvious that the design would have been of the object from a "**three-dimensional model**" to construct a real-world product and achieve "efficient product delivery" using the 3D printer. EX-1010, ¶¶[0004]-[0005], [0019]. This is consistent with the '774 patent, which similarly describes that a "three-dimensional model may include a three-dimensional design created by a user, e.g., using local or online tools for three-dimensional design and modeling." EX-1001, 18:21-23.

[1.2] determining a target printer to fabricate the object;

118. Hamilton's process of 3D printing includes querying "the user's 3D printer for its accuracy and material capabilities." EX-1010, ¶¶[0019], [0021], FIG. 3. If the printer capabilities are compatible with the requested 3D model, the model is sent to the user's 3D printer to fabricate the model. *Id.* A POSITA would have recognized that "the user's 3D printer" would be "**a target printer to fabricate the object**" because the user first requests a product 210 and the system waits for a response from the user to ensure that the printer is attached and ready. EX-1010, ¶[0020]. The attached printer would have been the target printer and would have been determined before "query[ing] the user's 3D printer for its

accuracy and material abilities 330.” EX-1010, ¶¶[0019]-[0021]. Furthermore, Hamilton’s query is evidence that its system is also determining the target printer in that it could reject the user’s 3D printer if its abilities were insufficient.

[1.3] querying the target printer for configuration information of the target printer relevant to creation of a printable model for fabrication of the object on the target printer;

119. As discussed above in [1.2], Hamilton’s process of 3D printing performs a “query” of the printer to be used that includes the printer’s “accuracy and material capabilities” (“***querying the target printer for configuration information of the target printer***”). EX-1010, ¶¶[0019]-[0021], FIG. 3; *see above*, [1.2]. The system then “compare[s] the capabilities of the printer to the requirements of the design” to determine whether to send the design file to the printer (“***configuration information of the target printer relevant to creation of a printable model for fabrication of the object on the target printer***”). *Id.* Hamilton also discloses “capability information” of the user’s printer includes “an indication of a material stock available to the 3D printer, and an indication of the 3D printer type.” EX-1017, ¶[0017], which are examples of claimed “hardware configuration” described in the ’774 Patent. EX-1001, 19:26-40 (disclosing “hardware configuration many include, ... one or more of a printer type (e.g., printer brand or general type of fabrication machine), ... a build material type or other properties of the build material;” claims 4, 5.

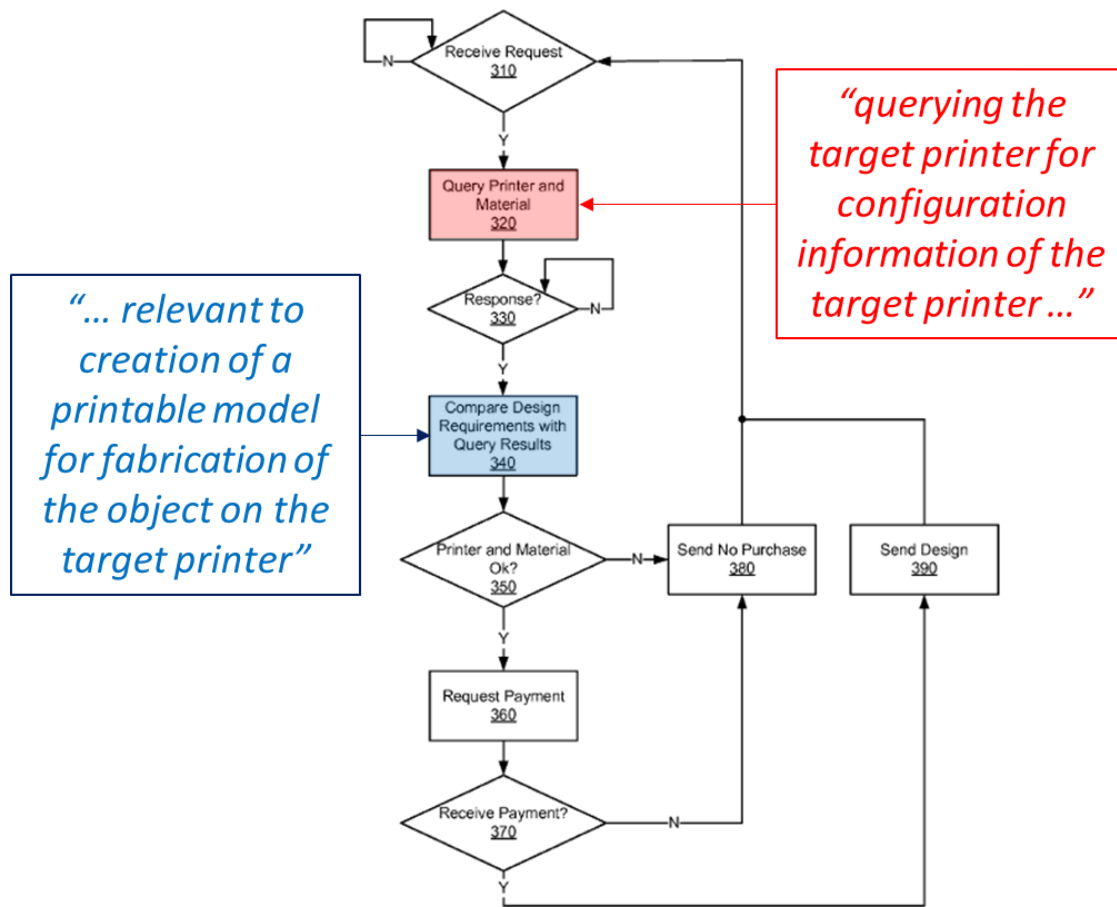


Fig. 3

EX-1010, FIG. 3.

[1.4] receiving, from the target printer, a dictionary of configuration information containing one or more properties from the target printer that affect fabrication capabilities of the target printer;

120. As discussed in [1.3] above, once Hamilton’s system queries the user’s printer for its capabilities, the printer “will then respond with its accuracy and material capabilities” (“***receiving, from the target printer, a dictionary of configuration information***”). As the name plainly suggests, the printer’s “accuracy and material capabilities” “***contain[] one or more properties from the***

target printer that affect fabrication capabilities of the target printer.” EX-1010, ¶¶[0015]-[0021], FIG. 3; *see above*, [1.3].

121. As discussed in Section IX-A-2-[1.4], the ’774 patent describes “[t]he dictionary may be a list or collection of the properties, or may be otherwise configured to organize the properties of the printer,” and “[t]he dictionary may define ...printing capabilities, ..., for the printer.” EX-1001, 21:24-26, 32-34. The collection of information sent by the printer related to printer “accuracy and material capabilities” constitutes *a dictionary of configuration information* because Hamilton discloses the “information consists of, but is not limited to, information on the accuracy of the printer, materials the printer is able to use, materials currently in the printer,” which is a collection of examples “*properties from the target printer that affect fabrication capabilities of the target printer*,” and defines the printer capabilities, consistent with the ’774 Patent’s disclosure. EX-1010, ¶¶[0016]-[0019], claims 1-5; EX-1001, 21:24-26.

122. Similar to Hamilton’s target printer’s “accuracy and material capabilities,” Evans also discloses “information about your printer and filament” (“*configuration information*” that “*affect[s] fabrication capabilities of the target printer*”) “such as filament diameter,” “extruder nozzle size,” and “layer height” is needed in order for the slicer to generate sliced layers for 3D printing. EX-1011, 43-46, 312. In the combination, as discussed above, a POSITA would

have recognized and found obvious that Hamilton’s target printer’s “accuracy and material capabilities” include additional information as disclosed by Evans because, as Evans explains, this information is needed and beneficial for the slicer application to generate codes that control the 3D printer to print the design. EX-1011, 43-46, 62; *see above*, §IX.E.1.

[1.5] creating a fabrication profile based on the one or more properties; and

123. As discussed above in [1.4], Evans discloses that, for a 3D printer to print an 3D object, “slicer” applications are needed to slice the model and generate machine-ready code that defines the toolpaths to be taken by the 3D printer (e.g., “G-code”). EX-1011, 43-46, 56; *see above*, [1.4]. To do so, the slicer “needs some general information about your printer and filament, such as the filament diameter, extruder nozzle size, and layer height,” as well as other “print settings” (“***the one or more properties***”). EX-1011, 43-46, 62. Evans describes a plurality of available slicing applications, one of which is “Slic3r” that “calculates” configurations (“***creating a fabrication profile***”) for generating the toolpaths upon receiving “only a few parameters about your printer, the filament” (“***based on the one or more properties***”). EX-1011, 43-46. Based on the familiarity with or use of the slicer applications, a POSITA would have known that the various properties shown in the example user interface of Slic3r’s “Print

Settings” and “Printer and Filament” would have been properties received from the printer and been automatically populated/filled, while allowing further user input/modification because automatically filled printer properties are known and desirable features in the slicer application by the Critical Date, which improve user experience as explicitly noted by Evans. *Id.* EX-1011, 43-46. A POSITA would have understood and found obvious that, in Hamilton-Evans, upon receiving the printer properties from the printer (e.g., Hamilton’s “accuracy and material capabilities” and Evan’s “information about your printer and filament”), the slicer would have created a fabrication profile such as example “configuration” of Slic3r shown in Evan’s FIG. 2-11, which is created based on the properties such as “Print Settings” and “Printer and Filament” properties. *Id.*; EX-1010, ¶¶[0015]-[0021], FIG. 3. A POSITA would have understood that such a configuration is a “fabrication profile” because it is a collection of information used for fabricating the object, and the fact the configuration can be “Saved” as a file after creation is further evidence that the configuration is a profile. EX-1011, FIGS. 2-11.

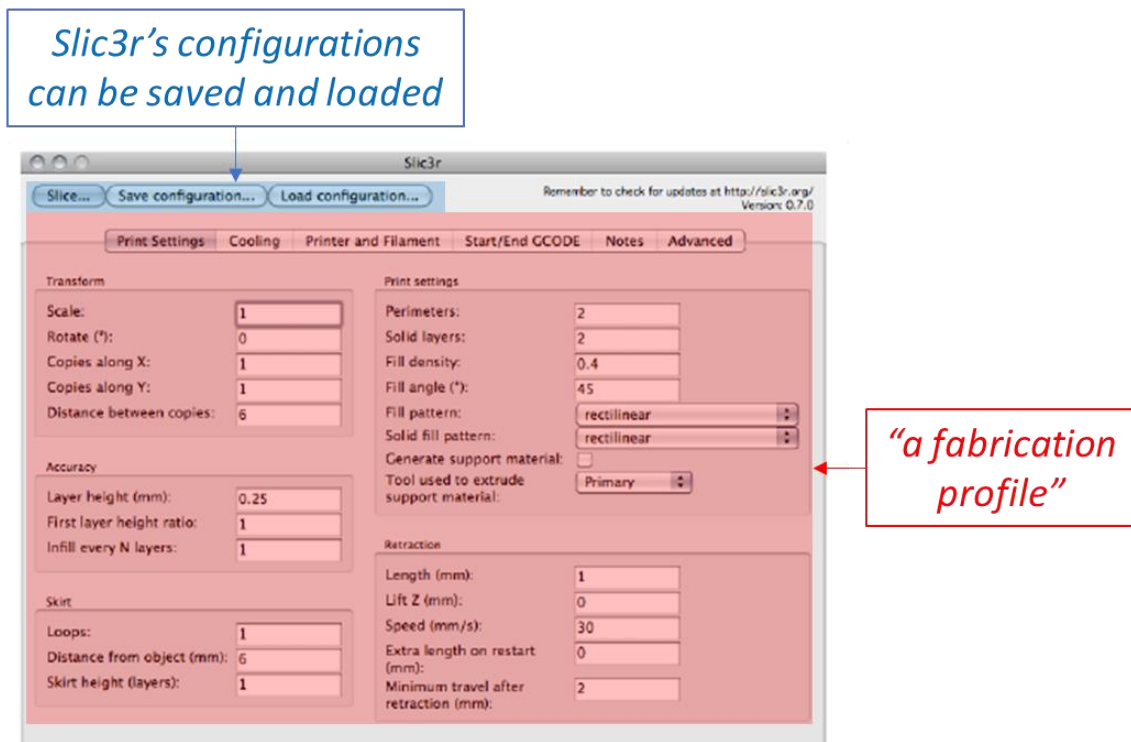
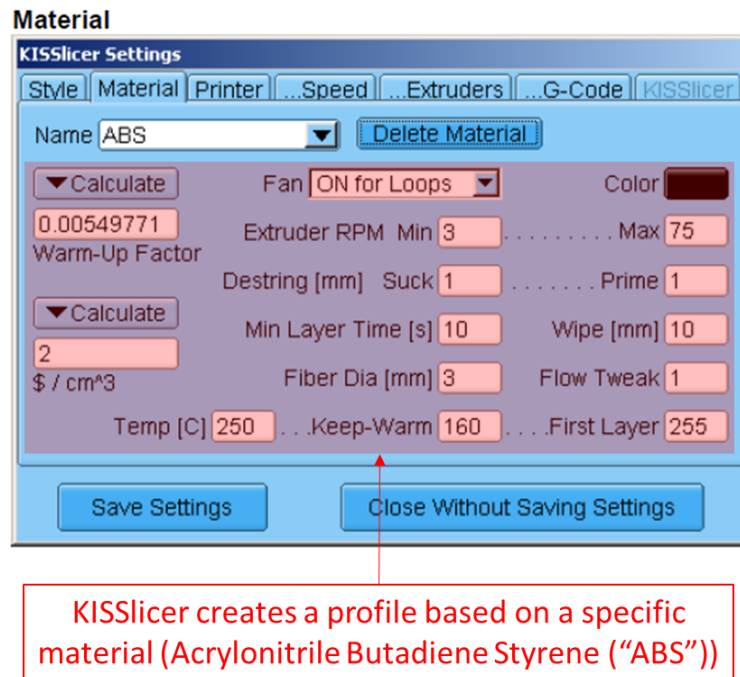


Figure 2-11. Slic3r 0.7.0

EX-1011, FIG. 2-11.

124. Additionally, it was well known in the art before the Critical Date for slicing applications to generate settings/configurations based on printer capabilities. For example, another publicly available slicing application, “KISSlicer,” creates “profiles” for each print that are based on printer capabilities, for example, the printer’s available materials. EX-1012, 3-11; EX-1015. An example KISSlicer profile is illustrated below.



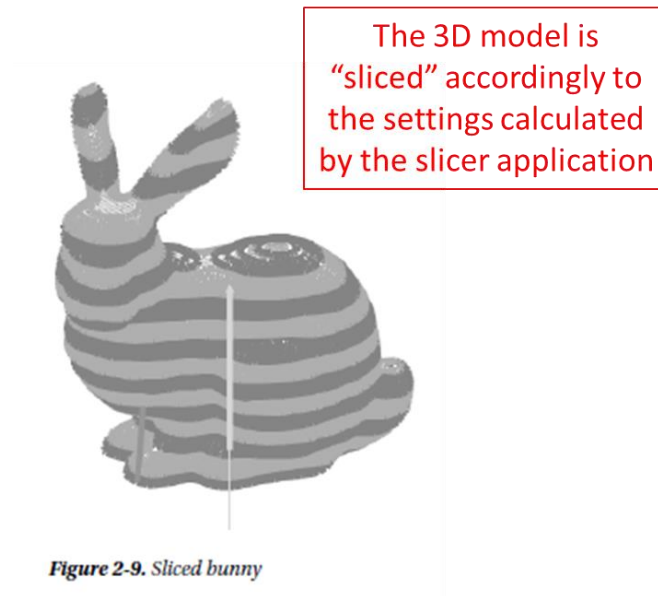
EX-1012, 3.

125. As such, a POSITA would have found it obvious that Hamilton-Evans, with or without KISSlicer, renders obvious of this limitation.

[1.6] generating a machine-ready representation of the three-dimensional model executable by the target printer to fabricate the object.

126. Evans discloses that the process of slicing the model “generate[s] a set of commands for the 3D printer to follow” (e.g., “G-code”) (“***generating a machine-ready representation of the three-dimensional model***”). EX-1011, 34, 43, 62, 70-71. Evans also discloses that, once G-code has been generated by the slicer, this code is used to fabricate the object defined by the code. EX-1011, 34-35, 70-71. Specifically, Evans discloses that a “printer control” application “process[es] the G-code file and[,] by communicating with the printer’s

electronics, it will send these commands to the 3D printer to build our objects layer by layer” (“*executable by the target printer to fabricate the object*”). *Id.*



EX-1011, 34.

The slicing application generates toolpaths for the 3D printer to follow

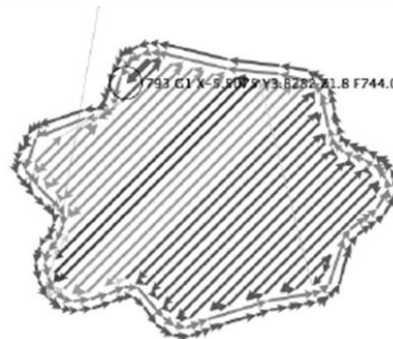


Figure 2-8. One layer of the Stanford bunny

EX-1011, 43.

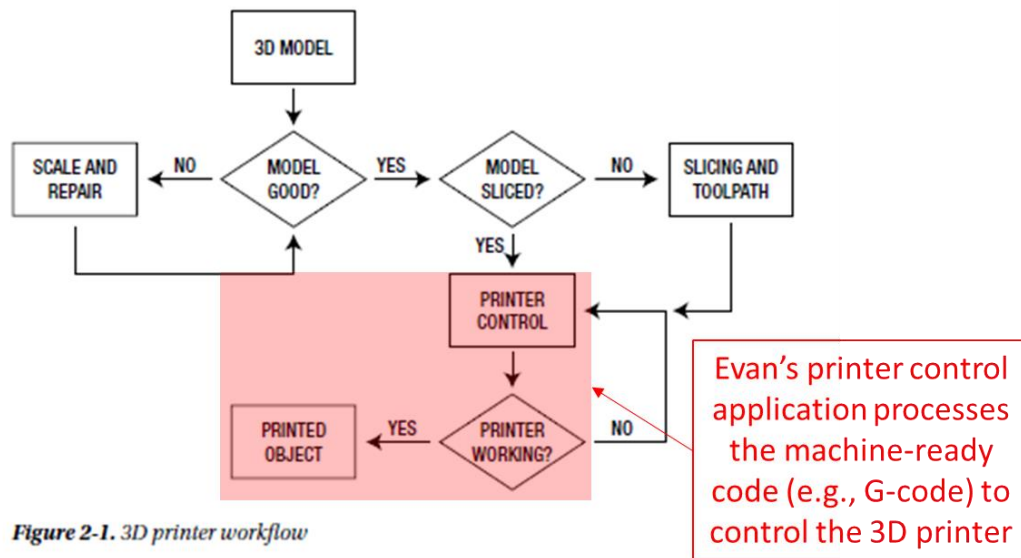


Figure 2-1. 3D printer workflow

EX-1011, FIG. 2-1.

[2] The method of claim 1 further comprising transmitting the machine-ready representation to the target printer for fabrication.

127. Hamilton discloses after the system determines that the printer's capabilities can meet the requirements of a print job and a payment is provided, the system will send the design of the to-be-printed object and cause the printer to print the object ("***fabricating the object with the target printer***"). EX-1010, ¶¶[0019]-[0022], FIGS. 1-4.

128. As discussed above in Section IX-E-1 and [1.6], a POSITA would have understood or found it obvious that Hamilton's system would have included a slicer that generates a machine-ready representation (e.g., G-code) corresponding to the design and send the machine-ready representation (e.g., G-code) for execution at the user's printer for fabricating the object. EX-1010, ¶¶[0016]-[0021], FIG. 3; EX-

1011, 43-46, 62. More specifically, Evans discloses the slicer, “a separate application,” generates and transmits the machine-ready representation (e.g., G-code) to the 3D printer for fabrication. EX-1011, 43, FIGS. 2-1, 2-2; EX-1010, ¶[0019]. Slicer applications are typically executed on a general purpose computer (e.g., in Hamilton’s system which determines whether the user’s printer is suitable and instructs the printer to fabricate the object) and the generated machine-ready code is transmitted to the 3D printer (either through a direct connection to a printer or over a network). EX-1011, 34-35 (describing a “Printer Control” application), 44 (“... the slicer application on your computer ...”). Evans explains that, once generated, the G-code file is “sent ... to the 3D printer” (“transmitting the machine-ready representation to the target printer for fabrication”). EX-1011, 34-35, 46-52.

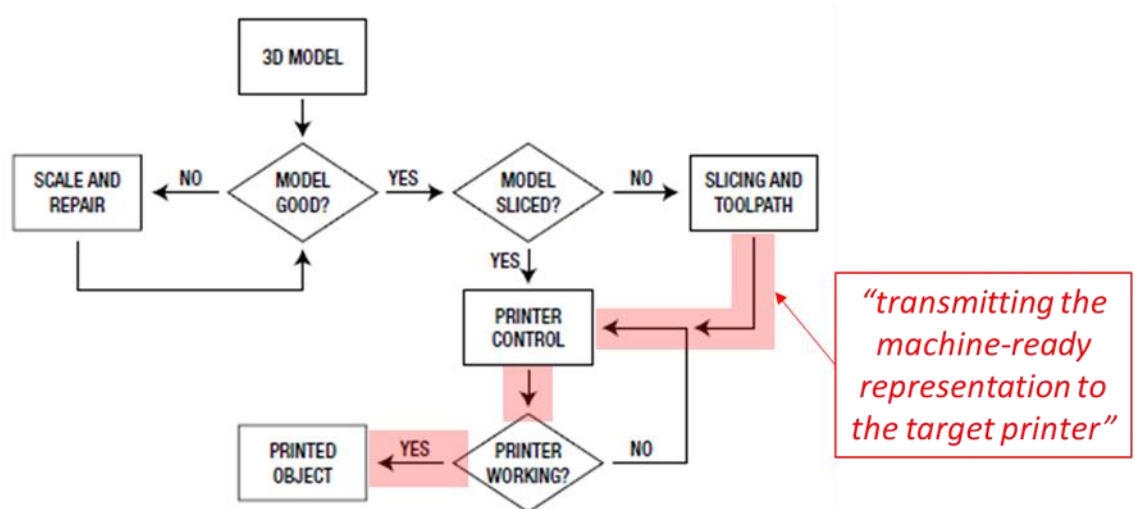


Figure 2-1. 3D printer workflow

EX-1011, FIG. 2-1.

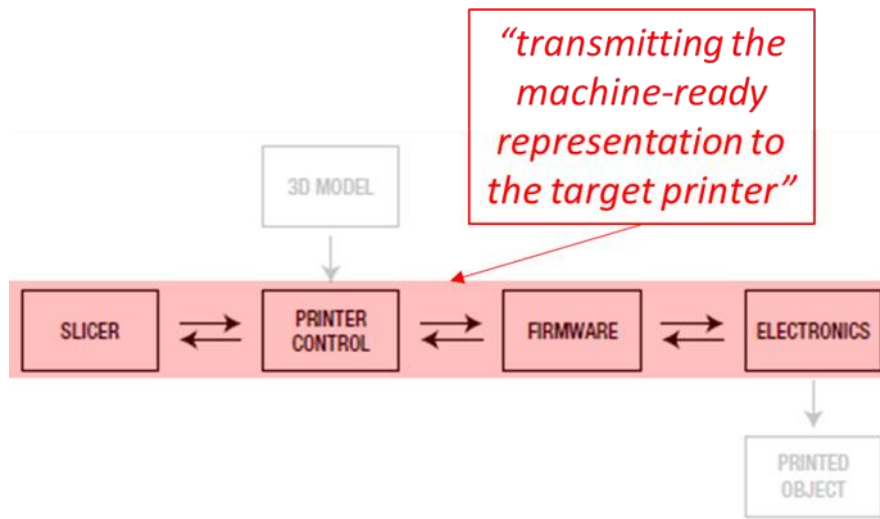


Figure 2-2. The 3D printer toolchain

EX-1011, FIG. 2-2.

[3] The method of claim 1 further comprising fabricating the object with the target printer.

129. Hamilton discloses “the printer will print each individual part to be assembled” (“*fabricating the object with the target printer*”). EX-1010, ¶[0022], FIG. 4.

[4] The method of claim 1 wherein the one or more properties include a hardware configuration of the target printer.

130. As discussed above in [1.3], Hamilton’s system queries the printer being used for its capabilities and the capabilities are transmitted from the printer. EX-1010, ¶¶[0019]-[0021], FIG. 3; *see above*, [1.3]. These capabilities include “materials the printer is able to use,” and “materials currently in the printer” (“*the one or more properties include a hardware configuration of the*

target printer”). EX-1010, ¶¶[0019], [0021].

131. Evans provides additional examples or details of material/filament material properties (e.g., “filament diameter”), as well as additional examples of hardware configuration information relevant to fabricating objects with a 3D printer, including: “extruder nozzle size, and layer height” along with “the print speed.” EX-1011, 44.

[5] The method of claim 4 wherein the hardware configuration includes one or more of an extruder type, an extruder nozzle diameter, a build volume, a build platform type, a hardware version number, a top speed for linear movement of a tool, a step size for movement of the tool, a minimum z-axis size, a gantry type, and a build material type.

132. As discussed above in [4], the information transmitted from the printer to Hamilton’s system includes “materials the printer is able to use,” and “materials currently in the printer,” (“**the hardware configuration**”), which include at least “**a build material type.**” EX-1010, ¶¶[0019]-[0021]; *see above*, [4].

133. Additionally, Evans provides additional examples of hardware configuration information relevant to fabricating objects with a 3D printer, including: “filament diameter, extruder nozzle size, and layer height” along with “print speed” (“**the hardware configuration includes ... an extruder nozzle diameter, a build volume ... [and] a top speed for linear movement of a tool**”). EX-1011, 44; *see above*, [4]. These parameters are all related to the printer’s

accuracy, and as discussed above, a POSITA would have found obvious that such parameters would be included in Hamilton's "accuracy and material capabilities" transmitted from the printers because they affect the printer's accuracy. EX-1010, ¶¶[0019]-[0021]; EX-1011, 62-70; *see above*, §IX.E.1. As such, Hamilton-Evans further renders claim 5 obvious.

[9] The method of claim 1 wherein the one or more properties include one or more user settings on the target printer.

134. Evans discloses that the one or more properties include numerous "print settings" that a user can alter to change the quality of their prints ("***the one or more properties include one or more user settings on the target printer***") to include a number of "perimeters," a number of "solid layers," an "infill" amount, a "layer height," a model "scale," a printer "nozzle size," and a "print speed," among others. EX-1011, 62-70.

135. Moreover, Evans discloses additional user settings on the target printer such as user's selection/replacement/change of filament materials, user calibration "which might include making mechanical adjustments to the printbed or endstops, setting parameters in firmware, and testing print settings like print speed, temperature, and layer height," as well as "various electrical and mechanical upgrades that [users] can buy, print, and make to improve...3D printer." EX-1011, 26, 55, 260-281, *see generally* Chapt. 3 and 10. A POSITA would have recognized

or found obvious that these selections/changes (e.g., materials or mechanical adjustments) made by the user on the target printer would have been included in Hamilton's "accuracy and material capabilities" sent from the target printer ("***properties that affect fabrication capabilities of the target printer***") because they are chosen/changed to improve the capability and quality of the fabrication and indicate "information on the accuracy of the printer, materials the printer is able to use, materials currently in the printer" as precisely disclosed by Hamilton. *Id.*; EX-1010, ¶¶[0019]-[0021].

[10] The method of claim 9 wherein the one or more user settings include user setting from a previous fabrication process.

136. Evans discloses that a user can set some print settings, "try another model using the same steps and settings," "and forget about them," such that these settings would have been used for multiple print jobs ("***the one or more user settings include user setting from a previous fabrication process***"). EX-1011, 62-70; *see above*, [9]. Similarly, Evans discloses that after "Choosing the right Material," and "Buying Filament," together with a spindle holder, "you will never need to worry about your filament again" such that the material properties (e.g., at least the type, the diameter, etc.) would remain the same as those of the filament installed by the user from a previous fabrication process ("***the one or more user settings include user setting from a previous fabrication process***").

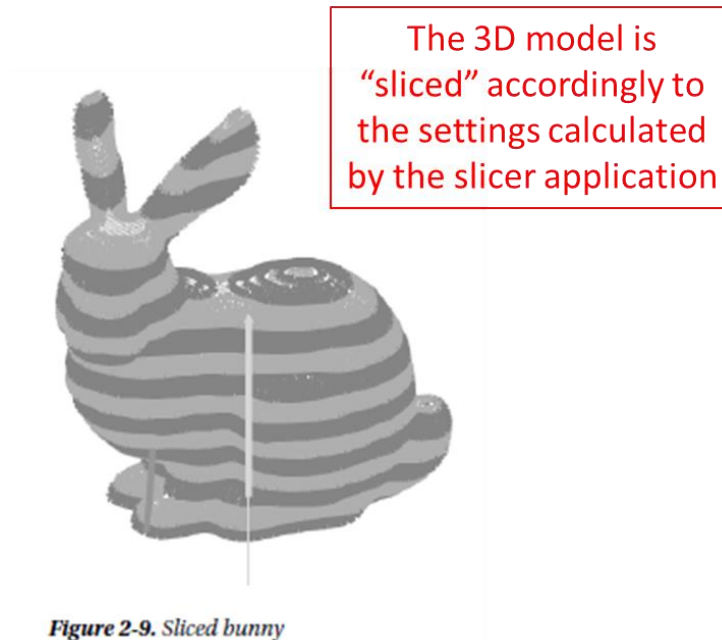
EX-1011, 26-27; *see above*, [9].

[12] The method of claim 1 wherein the one or more properties include a build material in the target printer.

137. As discussed above in [4], Hamilton's information transmitted from the printer includes "materials the printer is able to use," and "materials currently in the printer" ("**the one or more properties include a build material in the target printer**"). EX-1010, ¶¶[0019]-[0021]; *see above*, [4], [9] (discussing Evan's disclosure of filament materials); EX-1011, 26-27.

[13] The method of claim 1 wherein generating the machine-ready representation includes processing the three-dimensional model according to the fabrication profile.

138. As discussed above in [1.5], Evans discloses that "slicer" applications generate G-code ("**generating the machine-ready representation**") by slicing the "3D model" "into layers suitable for 3D printing" ("**processing the three-dimensional model**") based on the properties of the 3D printer (e.g., "nozzle size and filament diameter," "the speed at which the model is to be printed," "how solid the object is," etc.). EX-1011, 34, 43-46, 62; *see above*, [1.4]-[1.5]. Evans illustrates example "sliced" 3D models, reproduced below.



EX-1011, 44.

The slicing application generates toolpaths for the 3D printer to follow

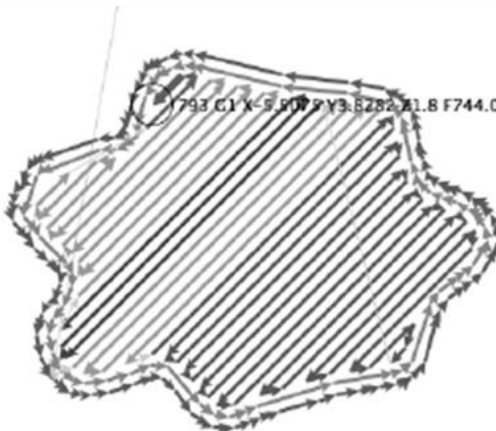


Figure 2-8. One layer of the Stanford bunny

EX-1011, 43.

139. As an example shown below in FIG. 2-11, in generating the G-code, Slic3r is configured to “slice” (“*process[es]*”) the 3D model according to the configurations (“*according to the fabrication profile*”). EX-1011, 34, 43-46.

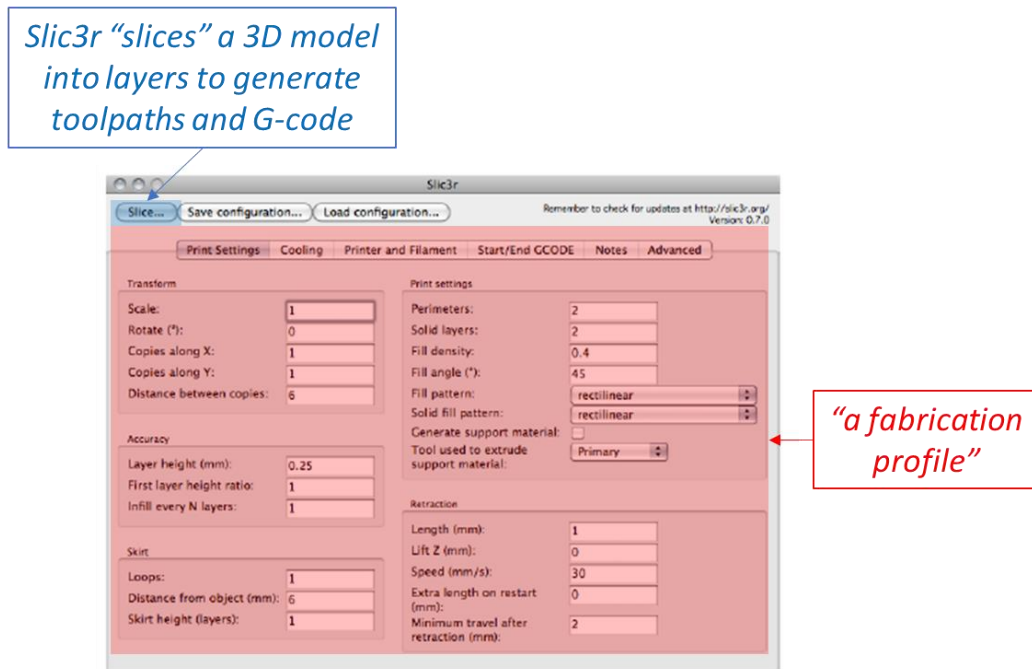


Figure 2-11. Slic3r 0.7.0

EX-1011, FIG. 2-11.

F. GROUND 2B—Hamilton in view of Evans and Pax, with or without KISSlicer, renders claims 6-7, 19 obvious

1. A POSITA would have combined Hamilton, Evans, and Pax

140. A POSITA would have been motivated to implement Hamilton-Evans’ system in a manner that employs Pax’s suggestions (e.g., checking the adequacy of materials, automatically or manually detecting new/replacement materials, and generating descriptive metadata specifying printer properties for comparison with

selected printer) to achieve several known benefits (articulated below) for multiple reasons. EX-1010, ¶¶[0016]-[0021], FIG. 3; EX-1011, 43-46, 62; EX-1013, ¶¶[0096]-[00101], FIG. 11.

141. First, Evans discloses that 3D printer filament is “like the ink or toner in a traditional printer,” and a POSITA would have recognized and found obvious that 3D printer filament must be replaced after it is exhausted or changed if a different material or color is desired. EX-1011, 26-27. Pax provides a manner for alerting the user when the printer’s supply of filament is low. EX-1013, ¶¶[0097]-[00101], FIG. 11. A POSITA would have been motivated to incorporate Pax’s user alert functionality in Hamilton-Evans to further improve user experience “so the user can obtain adequate build materials” without being wasting time on troubleshooting or frustrated with unsatisfactory print quality. EX-1013, ¶[00101].

142. Second, Pax’s system “automatically tracks material usage and updates material inventory with respect to an initial inventory.” EX-1013, ¶[0098]. A POSITA would have been motivated to incorporate Pax’s automatic material monitoring and update features into Hamilton-Evans’ 3D printer so the material update (e.g., a new/replacement material) supplied to the 3D printer can be automatically detected and transmitted as part of the 3D printer’s “accuracy and material abilities” for determining whether the printer’s capabilities meet the requirements of the design. EX-1013, ¶[0098]; EX-1010, ¶[0021]. In this way,

the “accuracy and material abilities” transmitted by the 3D printer would stay up-to-date, especially when there has been replacement of the materials, and a determination whether the printer’s capabilities meet the requirements of the design would be more reliable, and user experience would have been improved.

143. Third, Pax’s system allows “a user (e.g., an operator of the three dimensional printer) [to] be directly queried as to what build materials are available” and “a user [to] manually enter a color value for each build material or color source.” EX-1013, ¶[0098]. A POSITA would have been motivated to incorporate Pax’s user manual configuration features into Hamilton-Evans’ 3D printer to beneficially provide that the user with the option/flexibility to specify, e.g., the type, amount, color of a new/replacement material that the user supplies to the 3D printer, and such user specified properties would have been included and transmitted as part of the 3D printer’s “accuracy and material abilities” such that it can reflect the up-to-date printer’s capabilities for comparison with the requirements of the design. EX-1013, ¶[0098]; EX-1010, ¶ [0021]. As discussed above, the “accuracy and material abilities” transmitted by the 3D printer would lead to a more reliable determination of whether the printer’s capabilities meet the requirements of the design, and a better user experience.

144. Fourth, similar to Hamilton, Pax also discloses a “pre-fabrication check” that compares available build materials of a target printer with “the color and

material requirements” of a model. EX-1013, ¶¶[0096]-[0099], FIG. 11; EX-1010, ¶[0021]. More specifically, Pax discloses “the color and material requirements” can be included in “metadata.” *Id.* A POSITA would have been motivated to apply Pax’s suggestion of metadata that specifies the printer properties so as to facilitate a pre-fabrication check by comparing the properties of the printer with the requirement of the model in Hamilton-Evans system. For example, a POSITA would have been motivated to have metadata in the G-code files to ensure that G-code instructions were compatible with a printer, including build volume, filament width, and temperatures, all of which can vary from printer to printer. Having the metadata in the G-code files would have allowed POSITAs to not always revert to an object model software (or print engine software) to “check” for the correct parameters manually. Metadata in the G-code file can facilitate this check, as is commonly done.

145. Hamilton, Evans, and Pax are analogous art to the ’774 patent, which is generally directed to “the use of configuration information for a three-dimensional printer to select suitable machine-ready models.” EX-1001, 1:15-20. Hamilton generally describes a “product delivery system operable to deliver a virtual product which is manufactured locally using a 3D printer,” Evans is a “how-to-manual” for 3D printing, and Pax is generally directed to “three-dimensional printers using fused deposition modeling or similar techniques.” EX-1010, Abstract, ¶¶[0004]-[0006]; EX-1011, 4-6; EX-1013, ¶¶[0003]-[0010], [0028]-[0029], FIG. 1. Accordingly, the

prior art references are all directed to the same field of 3D printing. *Id.*

146. Additionally, as explained below in more detail, combining Hamilton-Evans and Pax would have been obvious at least because such a combination would have merely involved (1) combining prior art elements according to known methods to yield predictable results; and the (2) use of known technique to improve similar methods in the same way.

147. Incorporating Pax’s teachings into Hamilton-Evans would have been predictable and foreseeable with a reasonable expectation of success because Pax discloses that loaded materials can be detected with a “camera”—a well-known sensor within a POSITA’s general knowledge and skill that would have been implemented without significant modification to the printer. EX-1013, ¶[0094]; *see above*, §VIII.H. Further, metadata generation is a well-known and commonly used feature in the software of 3D printing (e.g., slicer) that would have been predictably implemented with reasonable expectation of success. EX-1013, ¶[0095]; EX-1011, 34, 61-62. A POSITA would have an understanding of what could be done in hardware (e.g., a sensor) and software (e.g., generating metadata) to incorporate Pax’s teachings into Hamilton-Evans combination, and could have done so by instructing and further working with programmers to code the software part if needed. With the predictable and foreseeable hardware and software implementations, the Hamilton-Evans-Pax combination would have been

reasonably successful.

2. Analysis

[6] The method of claim 4 wherein the hardware configuration includes an automatically detected hardware reconfiguration.

148. As an initial matter, the '774 patent describes the “**hardware reconfiguration**” includes “a new or replacement component on their printer.” EX-1001, 19:46-55.

149. Hamilton discloses “**the hardware configuration**” such as “materials the printer is able to use,” and “materials currently in the printer” EX-1010, ¶¶[0019]-[0021]. Evans discloses that 3D printer filament is “like the ink or toner in a traditional printer,” “Buying Filament,” and “Changing Filament.” EX-1011, 26-27. A POSITA would have recognized and found obvious that 3D printer filament must be replaced after it is exhausted or changed if a different material or color is desired. Evans explains that filaments come in different materials (e.g., “acrylonitrile butadiene styrene” (“ABS”), “polylactic acid” (“PLA”), “high-density polyethylene” (“HPDE”), and “polyvinyl alcohol” (“PVA”)), and that these materials affect the settings on the 3D printer (e.g., changing the printbed temperature). EX-1011, 26-27, 72. Because Hamilton discloses the printer would sent the information on “materials currently in the printer,” a POSITA would have recognized and found obvious that a new or replacement

material currently in the printer (“**hardware reconfigurations**”) would have been “**automatically detected**” and transmitted as it reflects the printer’s current “material capabilities” of the 3D printer. EX-1010, ¶¶[0019]-[0021].

150. Pax discloses a 3D printer that detects if loaded materials are “inadequate” (e.g., low on supply), and in response, notifies the user. EX-1013, ¶¶[0097]-[00101], FIG. 11. Pax also explains that its system “automatically tracks material usage and updates material inventory with respect to an initial inventory” (“**an automatically detected hardware reconfiguration**”) and “may reference the stored color value for corresponding calculations.” *Id.* It would have been obvious to a POSITA that, in the Hamilton-Evans-Pax combination, the printer’s “accuracy and material capabilities” sent from the printer would have included the automatically detected new or replacement material loaded by the user because it is critical information reflects the current “material capabilities” of the printer and is explicitly identified by Hamilton (i.e., “materials currently in the printer”) as an example of a **hardware configuration of the target printer** as discussed in [4] above. EX-1010, ¶¶[0019]-[0021]; EX-1013, ¶¶[0097]-[00101].

[7] The method of claim 4 wherein the hardware configuration includes a manually specified hardware reconfiguration.

151. As discussed above in [6], a “**hardware reconfiguration**” includes the changing or replacement of printer materials or other components. *See above,*

[6]. Evans discloses, for “Changing Filament,” “[w]ith the new filament installed,” “[b]e sure to measure the diameter of your new filament and adjust your slicer settings accordingly before you make that first print” (“***a manually specified hardware reconfiguration***”). EX-1011, 294-295.

152. Pax discloses multiple examples of “***a manually specified hardware reconfiguration***” such as “a user may manually enter a color value for each build material or color source” when loading printer materials, and if materials are inadequate, the user is notified so “the user can obtain adequate build materials.” EX-1013, ¶¶[0097]-[00101], FIG. 11.

153. It would have been obvious to a POSITA that, in the Hamilton-Evans-Pax combination, the printer’s “accuracy and material capabilities” sent from the printer would have included the ***manually specified*** new or replacement material loaded and the color or color source specified by the user because they are critical information related to the current fabrication capability of the printer and are explicitly identified by Hamilton (e.g., “materials the printer is able to use,” and “materials currently in the printer”) as examples of a ***hardware configuration of the target printer*** as discussed in [4] above. *Id.*; EX-1010, ¶¶[0019]-[0021]; see above, [4].

[19] The method of claim 1 further comprising generating descriptive metadata to accompany the machine-ready representation, the descriptive metadata specifying one or more properties for comparison to properties of printers selected for fabricating the model.

154. As discussed in §IX.D.2, Pax discloses and/or renders obvious generating “metadata” (“***descriptive metadata***”) to accompany “fabrication instructions” such as (“gcode”) (“***the machine-ready representation***”) to include “color and material requirements for fabricating the object” (“***specifying one or more properties***”) for “pre-fabrication check [that] compare[s] the color and material requirements to the available build materials [of selected printer]” (“***for comparison to properties of printers selected for fabricating the model***”). See above, §IX.D.2; EX-1013, ¶¶[0096]-[0099], FIG.11.

G. GROUNDS 2C—Hamilton in view of Evans, Pax and Pettis, with or without KISSlicer, renders claim 19 obvious

1. A POSITA would have combined Hamilton, Evans, Pax, and Pettis

155. A POSITA would have combined Hamilton-Evans-Pax with Pettis to generate the metadata to accompany the machine-ready model for multiple reasons.

156. First, Pettis discloses metadata 308 that include useful information such as “printability, build material requirements,... for the object” is generated to accompany machine-ready models 314 for fabricating the object in a data structure 300, which can “provide convenient user access to machine-ready models for fabrication, ... facilitate these user interactions..., permit[] convenient retrieval of

relevant data on a user-by-user or printer-by-printer basis.” EX-1009, ¶¶[0058]-[0062]. A POSITA would have been motivated to incorporate Pettis’s metadata generation features, especially arrangement the metadata to accompany the machine-ready models, into Hamilton-Evans-Pax with Pettis to achieve those advantages. *Id.*

157. Second, Pettis also discloses that its data structure with the metadata accompanying the machine-ready models of a 3D model would help “verify the suitability of machine-ready models 314 for fabrication on an intended device” (i.e., the selected printer), which is consistent with and further facilitates Pax’s use of the metadata for “pre-fabrication check,” e.g., by providing easier and faster access to the properties stored in the metadata for comparison/verification/check and to the corresponding machine-ready model for fabricating the object. EX-1009, Abstract, ¶¶[0060]-[0062], [0067]-[0068], FIGS.3-4; *see above* §IX.F.2.[19].

158. Hamilton, Evans, Pax, and Pettis are analogous art to the ’774 patent, which is generally directed to “the use of configuration information for a three-dimensional printer to select suitable machine-ready models.” EX-1001, 1:15-20. Indeed, Hamilton generally describes a “product delivery system operable to deliver a virtual product which is manufactured locally using a 3D printer,” Evans is a “how-to-manual” for 3D printing, Pax is generally directed to “three-dimensional printers using fused deposition modeling or similar techniques,” and Pettis is generally related to providing “a suitable, corresponding machine-ready model for immediate

fabrication by the printer.” EX-1010, Abstract, ¶¶[0004]-[0006]; EX-1011, 4-6; EX-1009, Abstract; EX-1013, ¶¶[0003]-[0010], [0028]-[0029], FIG. 1. Accordingly, the prior art references are all directed to the same field of 3D printing. *Id.*

159. Additionally, as explained below in more detail, combining Hamilton-Evans-Pax and Pettis would have been obvious at least because such a combination would have merely involved (1) combining prior art elements according to known methods to yield predictable results; and the (2) use of known technique to improve similar methods in the same way.

160. Incorporating Pettis’s teachings into Hamilton-Evans would have been predictable and foreseeable with a reasonable expectation of success because Evans discloses MakerBot systems, the underlying system provided by the Applicant of Pettis, as example commercially available 3D printing system. EX-1009, Cover; *see e.g.*, EX-1011, 10-12, 16-17, 23, 37, 43. Mark and Pax also disclose that it is known to generate and/or use metadata in 3D printing. *See e.g.*, EX-1006, 13:4-19, 14:14-23; EX-1013, ¶¶[0097], [00120]. In fact, generating metadata is a well-known, routinely adopted feature of the 3D printing system by the Critical Data. EX-1006, 13:4-19, 14:14-23; EX-1013, ¶¶[0097], [00120]. Configuring Hamilton-Evans’ system to generate the metadata in a similar manner as Pettis would have would have been well within a POSITA’s capability. EX-1005, ¶¶[0023]-[0024]; EX-1009, ¶¶[0052]-[0058]. Additionally, a POSITA would have an understanding of what

could be done in software to generate the descriptive metadata and could implement the combination by instructing and further working with programmers to code it, if needed, with a reasonable expectation of success. Configuring Hamilton-Evans-Pax' system to generate the metadata to accompany the machine-ready representation as taught in Pettis would have been well within a POSITA's capability with a reasonable expectation of success. EX-1009, ¶¶[0052]-[0058].

2. Analysis

[19] The method of claim 1 further comprising generating descriptive metadata to accompany the machine-ready representation, the descriptive metadata specifying one or more properties for comparison to properties of printers selected for fabricating the model.

161. As discussed in §IX.F.2.[19], Pax discloses “metadata” that specifies “color and material requirements” (“***one or more properties***”) for “pre-fabrication check [that] compare[s] the color and material requirements to the available build materials [of selected printer]” (“***for comparison to properties of printers selected for fabricating the model***”). See above, §IX.F.2.[19]; EX-1013, ¶¶[0096]-[0099], FIG.11.

162. It would have been obvious to provide metadata to accompany “fabrication instructions” (“***machine-ready representation***”), a POSITA would have found it obvious in the Hamilton-Evans-Pax-Pettis combination based on Pettis' explicit disclosure of such. As shown in FIG. 3, Pettis explicitly discloses the

generation of the metadata to accompany the machine-ready models, where “useful metadata” such as metadata 308 is generated to accompany “**machine-ready models 314**” (“*the machine-ready representation*”) in “a data structure for storing machine-ready models of three-dimensional object.” EX-1009, ¶¶[0008], [0062]-[0063], FIG.3. Further, to the extent that generating metadata and the machine-ready representation is interpreted to require simultaneous generation of both, Pettis discloses that “other steps such as verifying models and creating/storing metadata may be performed in any order or with any priority suitable to anticipated use of the system.” EX-1009, ¶[0081].

H. GROUND 2D—Hamilton in view of Evans and Batchelder, with or without KISSlicer, renders claim 8 obvious

1. A POSITA would have combined Hamilton, Evans, and Batchelder

163. It would have been obvious for a POSITA to combine the teachings of Hamilton-Evans and Batchelder to incorporate software and firmware information of a 3D printer into printer accuracy and material abilities/capabilities transmitted by the printer to the system for determining whether the printer is suitable for a print job for at least the following reasons.

164. First, Evans highlights the importance of printer firmware and explains the “printer control ... communicates with a specialized set of code called firmware” that “controls the electronics hardware to build our 3D objects according to the

instructions received from the printer control,” and further, describes that “[h]ow well firmware [interprets G-code] will determine how well your 3D printer will print objects.” EX-1011, 35, 41-43, 76-80. Given the importance of firmware in affecting the fabrication capability of the printer and the explicit disclosure of Batchelder, a POSITA would have been motivated to include the firmware configuration into the information transmitted by the printer (e.g., Hamilton’s the printer “accuracy and material capabilities”) to facilitate Hamilton’s functions of determining a target printer suitable for a specific print job. EX-1010, ¶¶[0015]-[0021], FIG. 3.

165. Second, incorporating the firmware configuration (e.g., the current version or update) into Hamilton-Evans system would have improved the quality of resulting prints because, with the knowledge of the firmware configuration, a more compatible G-code can be generated based on the user’s printers control applications. Especially before the year 2012 and sooner, 3D printing hardware was changing rapidly. And it was common for a POSITA to ensure that firmware updates were performed regularly to ensure that the most compatible G-code instructions were generated.

166. Third, incorporating the firmware configuration (e.g., the current version or update) into Hamilton-Evans system would have improved user experience. For example, verifying a printer firmware configuration before starting a print job would prevent a user from having to resubmit a print job after

the first job failed to complete. EX-1007, ¶¶[0052]-[0054], FIG. 2; EX-1010, ¶¶[0019]-[0021].

167. Hamilton, Evans, and Batchelder are analogous art to the '774 patent, which is generally directed to “the use of configuration information for a three-dimensional printer to select suitable machine-ready models.” EX-1001, 1:15-20. Hamilton generally describes a “product delivery system operable to deliver a virtual product which is manufactured locally using a 3D printer,” Evans is a “how-to-manual” for 3D printing, and Batchelder is generally related to “additive manufacturing systems for building three-dimensional (3D) models.” EX-1010, Abstract, ¶¶[0004]-[0006]; EX-1011, 4-6; EX-1008, ¶¶[0004]-[0010]. Accordingly, the prior art references are all directed to the same field of 3D printing. *Id.*

168. Additionally, as explained below in more detail, combining Hamilton-Evans and Batchelder would have been obvious at least because such a combination would have merely involved (1) combining prior art elements according to known methods to yield predictable results; and the (2) use of known technique to improve similar methods in the same way.

169. Incorporating Batchelder’s teachings into Hamilton-Evans would have been predictable and foreseeable with a reasonable expectation of success because Evans discloses that a printer’s firmware is part of the “toolchain”—the overall system of control software that drives the 3D printer. EX-1011, 33-43; EX-1007,

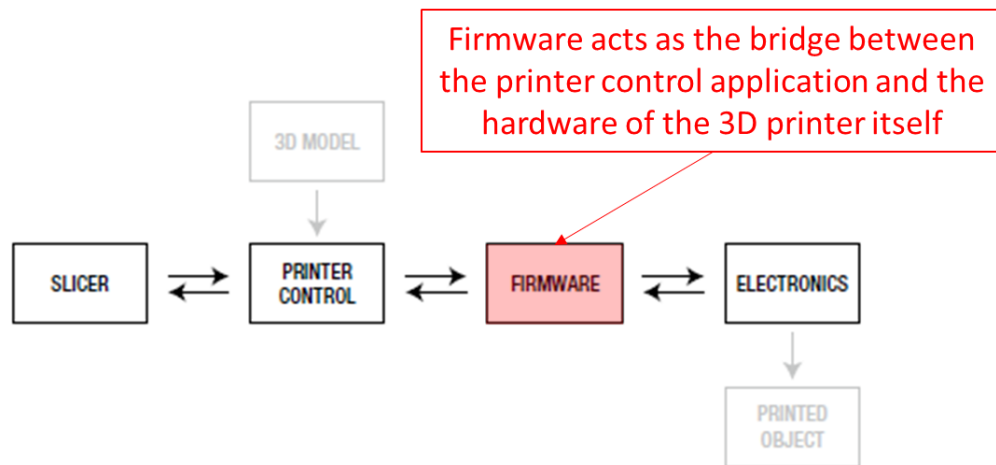
¶¶[0052]-[0058]. Further, Evans provides an example of “MakerBot” firmware—a company that was later acquired by “Stratasys,” the assignee of Batchelder. EX-1011, 43; EX-1007, Cover; EX-1017. A POSITA would have reasonably believed that Batchelder’s techniques of using and transmitting firmware information to assist in building 3D model would have been compatible with Hamilton-Evans because of (1) Evans’ general discussion of firmware in the 3D printing toolchain, (2) the fact that Evans specific examples of firmware (e.g., MakerBot firmware) was owned by the assignee of Batchelder before the Critical Date, and (3) Hamilton already discloses a printer sending various printer accuracy and material capability information to the system, and including another useful and beneficial information such as firmware information in it would have been well within a POSITA’s capability. EX-1010, ¶¶[0019]-[0021]; EX-1007, Cover, ¶¶[0052]-[0058]; EX-1011, 33-43; EX-1017. Additionally, a POSITA would have an understanding of what could be done in software to generate the descriptive metadata and could implement the combination by instructing and further working with programmers to code it, if needed, with a reasonable expectation of success.

2. Analysis

[8] The method of claim 1 wherein the one or more properties include a firmware configuration of the target printer.

170. The combination renders this obvious in multiple ways.

171. First, a 3D printer's firmware was typically detected when setting up or sending jobs to a 3D printer ("***a firmware configuration of the target printer***"), as the printer's firmware had a significant effect on the capabilities of the printer and its compatibility to the user's printers control applications. Evans corroborates the importance of printer firmware and explains the "printer control ... communicates with a specialized set of code called firmware" that "controls the electronics hardware to build our 3D objects according to the instructions received from the printer control," and further, describes that "[h]ow well firmware [interprets G-code] will determine how well your 3D printer will print objects." EX-1011, 35, 41-43, 76-80. Evans explains that printer control and firmware are intertwined, and to even begin utilizing a 3D printer, the printer's firmware would have needed to have been compatible with the corresponding printer control application. *Id.* To that end, a POSITA would have understood and found obvious that a printer's firmware configuration (e.g., any current version or update) would have been queried or at least received from the printer as one of the ***properties that affect fabrication capabilities of the target printer*** to ensure its compatibility with the user's printer control application. *Id.*



EX-1011, 35.

172. Second, Batchelder explicitly discloses “firmware updates for the system” (“*a firmware configuration of the target printer*”) as example printer property “assist[s] in building 3D model” (“*properties from the target printer that affect fabrication capabilities of the target printer*”). EX-1007, ¶¶[0052]-[0054], FIG. 2. As discussed above, a POSITA would have found it obvious to include the *firmware configuration of the target printer* in the printer “accuracy and material abilities”/capabilities transmitted from the printer to the system to facilitate the print job because the important role that the firmware configuration in affecting fabrication accuracy and capabilities of the target printer, as confirmed by both Evans and Batchelder.

I. GROUNDS 2E—Hamilton in view of Evans and Wang, with or without KISSlicer, renders claim 20 obvious

1. A POSITA would have combined Hamilton, Evans, and Wang

173. A POSITA would have been motivated to implement Hamilton-Evans' system in a manner that employs Wang's teaching of determining a printer's geographic location). EX-1010, ¶¶[0016]-[0019], [0021], FIG. 3; EX-1014, 7:60-8:5. A POSITA would have been motivated to combine Hamilton-Evans and Wang for at least the following reasons.

174. Hamilton discloses that a user's 3D printer might not meet the requirements of a requested print job but does not provide a solution to still fulfill request print job. EX-1010, ¶¶[0021]-[0022]. Wang provides such a solution by providing a plurality of print bureaus and "identify[ing] a subset of the plurality print bureaus that are able to print the 3D model." EX-1014, Abstract. A POSITA would have been motivated to combine the teachings of Wang with Hamilton-Evans to provide a backup 3D printer that can fulfill a print job when a user's 3D printer is not able to.

175. Moreover, Wang discloses the "geographical location of the printer" ("*a geographic location of the target printer*") can be collected and used in selecting print bureaus suitable for a print job. EX-1014, 7:60-8:5, 10:12-24, 11:33-41. A user would have been interested in selecting a printer to print objects close to their

geographic location to minimize shipping or travel expenses, which can facilitate Hamilton's goal of "efficient product delivery." EX-1014, 2:19-62, 7:60-8:5; EX-1010, ¶¶[0001]-[0003]. Accordingly, a POSITA would have been motivated to ensure that, in the event a user's printer was not able to print the design, a suitable alternative could have been identified within a reasonable distance to the user (e.g., using Wang's techniques in determining geolocations of the printers). EX-1010, ¶¶[0001]-[0006], [0019], [0021], FIG. 1; EX-1014, 2:19-62, FIG. 2.

176. Hamilton, Evans, and Wang are analogous art to the '774 patent, which is generally directed to "the use of configuration information for a three-dimensional printer to select suitable machine-ready models." EX-1001, 1:15-20. Hamilton generally describes a "product delivery system operable to deliver a virtual product which is manufactured locally using a 3D printer," Evans is a "how-to-manual" for 3D printing, and Wang is generally directed to "techniques for printing a three-dimensional (3D) object." EX-1010, Abstract, ¶¶[0004]-[0006]; EX-1011, 4-6; EX-1014, Abstract, 1:24-57. Accordingly, the prior art references are all directed to the same field of 3D printing. *Id.*

177. Additionally, as explained below in more detail, combining Hamilton-Evans and Wang would have been obvious at least because such a combination would have merely involved (1) combining prior art elements according to known methods to yield predictable results; and the (2) use of known technique to improve

similar methods in the same way.

178. Incorporating Wang's teachings into Hamilton-Evans would have been predictable and foreseeable with a reasonable expectation of success because Hamilton discloses an analogous remote 3D printing service where requests are received over a "communication network." EX-1010, FIG. 1; EX-1014, 2:19-62, FIG. 2. Determining the geographic location of a printer in such a system would have been within the general knowledge and skill of a POSITA, as evidenced by prior art references before the Critical Date. For example, Heiney discloses a technique where printers are discovered by querying an Internet Protocol (IP) address with HyperText Transport Protocol (HTTP) requests. EX-1018, Abstract, ¶¶[0018]-[0031]. Additionally, a POSITA would have an understanding of what could be done in software to determine a geolocation of a printer for determining a target printer for a print request and could implement the combination by instructing and further working with programmers to code it, if needed, with a reasonable expectation of success.

2. Analysis

[20] The method of claim 1, wherein determining a target printer to fabricate the object comprises determining a geographic location of the target printer.

179. Wang discloses that the "print bureau data collection engine 214" within its broker system "collect[s] information" from each of the print bureaus that

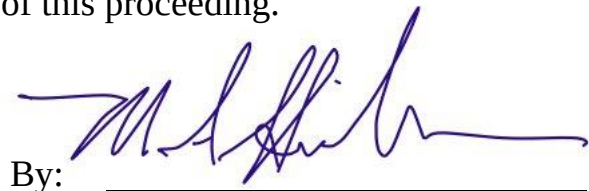
include the “geographical location of the printer” (“***a geographic location of the target printer***”). EX-1014, 7:60-8:5. As discussed above, in the combination, the geographic location of the printer would have been determined in the combined system before starting a prompt job (“***determining a target printer to fabricate the object comprises determining a geographic location of the target printer***”). *Id.*; *see above*, §IX.I.1.

X. ADDITIONAL REMARKS

180. I currently hold the opinions expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

181. I hereby declare that all statements made are of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code and that such willful false statements may jeopardize the validity of this proceeding.

Dated: Feb 14, 2025



By: _____
Michael A. Hickner, PhD
East Lansing, MI