

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Pettis
U.S. Patent No.: 8,562,324 Attorney Docket No.: 56224-0014IP1
Issue Date: October 22, 2013
Appl. Serial No.: 13/348,896
Filing Date: Jan. 12, 2012
Title: NETWORKED THREE-DIMENSIONAL PRINTING

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**PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT
NO. 8,562,324 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42**

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EXHIBITS

EX1001	U.S. Patent No. 8,562,324 to Pettis (“the ’324 Patent”)
EX1002	Excerpts from the Prosecution History of the ’324 Patent (“the Prosecution History”)
EX1003	Declaration of Dr. Andrew Wolfe
EX1004	U.S. Patent No. 6,580,959 to Mazumder (“Mazumder”)
EX1005	U.S. Patent Pub. No. 2010/0063615 to Mori et al. (“Mori”)
EX1006	U.S. Patent Pub. No. 2009/0015668 to Tian et al. (“Tian”)
EX1007	Japanese Patent Publication Number JP2000218708
EX1008	Certified English Translation of Japanese Patent Publication Number JP2000218708 (“Hull”)
EX1009	U.S. Patent No. 5,278,479 to Seki et al. (“Seki”)
EX1010	U.S. Patent Pub. No. 2006/0171452 to Waehner (“Waehner”)
EX1011	Lan, <i>Web-based Rapid Prototyping and Manufacturing Systems: A Review</i> , Computers in Industry (December 2009) (“Lan”)
EX1012	U.S. Patent Pub. No. 2004/0207662 to Anderson et al. (“Anderson”)
EX1013	Tay et al., <i>Distributed Rapid Prototyping – A Framework for Internet Prototyping and Manufacturing</i> , Integrated Manufacturing Systems (November 2001) (“Tay”)
EX1014	Henke et al., <i>Rapid Prototyping Modules for Remote Engineering Applications</i> , International Journal of Online

Engineering, Vol. 4, Issue 1 (July 2008), *available at*
<https://online-journals.org/index.php/i-joe/article/view/532/513>
("Henke") (also available at
<https://core.ac.uk/download/pdf/224750644.pdf>).

- EX1015 U.S. Patent Pub. No. 2006/0054039 to Kritchman et al.
("Kritchman")
- EX1016 Exhibit J of Infringement Contentions from *Stratasys, Inc., v. Shenzhen Touzhu Technology Co., Ltd., et al.*, Case Nos. 2:24-cv-00644-JRG and 2:24-cv-00645-JRG (E.D. Tex. Nov. 14, 2024).
- EX1017 Declaration of June Munford
- EX1018 December 18, 2024 stipulation sent by Petitioner's counsel to Patent Owner's counsel
- EX1019 Docket Control Order (Document 34), *Stratasys, Inc. v. Shenzhen Tuozhu Technology Co. Ltd. et al*, 2-24-cv-00645 (EDTX)

LISTING OF CLAIMS

<u>Claim Element</u>	<u>Language</u>
[1.pre]	A device comprising:
[1.a]	a three-dimensional printer including a build volume;
[1.b]	a network interface coupled to a data network;
[1.c]	a video camera positioned to capture video of the build volume from a point of view; and
[1.d]	a processor configured to receive a three-dimensional model through the network interface, and to control operation of the three-dimensional printer to fabricate the three-dimensional model as an object within the build volume of the three-dimensional printer, the processor further configured to provide a user interface to a remote user accessing the device through the network interface, and to present in the user interface an image of the build volume from the video camera and a two-dimensional projection of the three-dimensional model from the point of view of the video camera.

<u>Claim Element</u>	<u>Language</u>
[3]	The device of claim 1 wherein the two-dimensional projection is simulated based upon operation of the three-dimensional printer
[4]	The device of claim 3 wherein the processor is configured to monitor operation of the three-dimensional printer based upon a comparison of the two-dimensional projection with the image of the build volume
[5]	The device of claim 1 wherein the two-dimensional projection is dynamically updated to correspond to a state of physical completion of the object.
[6]	The device of claim 1 wherein the two-dimensional projection is a video image from the video camera
[7]	The device of claim 1 wherein the user interface provides at least one control for manual operation of the three-dimensional printer by the remote user.
[8]	The device of claim 1 wherein the processor is configured to provide credential-based access to the user interface.

<u>Claim Element</u>	<u>Language</u>
[9]	The device of claim 1 wherein the user interface provides status information for the three-dimensional printer.
[10]	The device of claim 1 wherein the user interface provides status information for a build process executing on the three-dimensional printer.
[11]	The device of claim 1 wherein the user interface displays a two-dimensional tool path for the three-dimensional printer, the two-dimensional tool path corresponding to a current layer of the object during a fabrication of the object by the three-dimensional printer.
[17]	The device of claim 1 wherein the user interface includes at least one control to capture a stop-motion animation of a fabrication of the object using the video camera.
[18]	The device of claim 1 wherein the processor is configured to couple the three-dimensional printer in a communicating relationship with a remote print server through the data network.

<u>Claim Element</u>	<u>Language</u>
[19.pre]	A method comprising:
[19.a]	providing a three-dimensional printer including a build volume, a network interface coupled to a data network, and a video camera positioned to capture video of the build volume from a point of view;
[19.b]	receiving a three-dimensional model through the network interface;
[19.c]	fabricating the three-dimensional model as an object within the build volume of the three-dimensional printer; and
[19.d]	providing a user interface to a remote user accessing the device through the network interface, wherein the user interface presents an image of the build volume from the video camera and a two-dimensional projection of the three-dimensional model from the point of view of the video camera.
[20]	The method of claim 19 further comprising transmitting status information over the data network upon completion of the object.

<u>Claim Element</u>	<u>Language</u>
[21]	The method of claim 20 wherein the status information includes data presented through the user interface.
[22]	The method of claim 20 wherein the status information includes a digital image from the video camera.

Petitioner Shenzhen TuoZhu Technology Co., Ltd. petitions for IPR of claims 1, 3-11, and 17-22 (“the Challenged Claims”) of U.S. Patent No. 8,562,324 (“the ’324 Patent”).

I. REQUIREMENTS FOR IPR UNDER 37 C.F.R. § 42.104

A. Grounds for Standing—37 C.F.R. §42.104(a)

Petitioner certifies that the ’324 Patent is available for IPR, and Petitioner is not barred or estopped from requesting IPR.

B. Challenge and Relief Requested—37 C.F.R. §42.104(b)

Petitioner requests IPR on grounds 1A-2G listed below. An expert declaration from Dr. Wolfe supports each ground. *See* EX1003.

<u>Ground</u>	<u>Claims</u>	<u>Basis for Rejection (35 U.S.C. § 103)</u>
1A	1, 3, 5-7, 9-10, and 19-22	Mazumder+Mori
1B	4	Mazumder+Mori+Tian
1C	8	Mazumder+Mori+Hull
1D	11	Mazumder+Mori+Seki
1E	17	Mazumder+Mori+Waehner
1F	18	Mazumder+Mori+Lan
1G	20-22	Mazumder+Mori+Anderson
2A	1, 3, 5-7, 9-10, and 19-22	Kritchman+Tay+Henke
2B	4	Kritchman+Tay+Henke+Tian
2C	8	Kritchman+Tay+Henke+Hull
2D	11	Kritchman+Tay+Henke+Seki
2E	17	Kritchman+Tay+Henke+Waehner

<u>Ground</u>	<u>Claims</u>	<u>Basis for Rejection (35 U.S.C. § 103)</u>
2F	18	Kritchman+Tay+Henke+Lan
2G	3, 5, 9-10, 20-22	Kritchman+Tay+Henke+Anderson

All publications cited in Grounds 1A-2G are §102(b) prior art publications, except for the Mori reference, which is a prior art publication under §102(a), (published Mar. 11, 2010) and §102(e) (filed Sep. 4, 2009). Regarding the non-patent references, the evidence of record demonstrates that Tay, Hanke, and Lan were publicly available through various libraries and through direct subscription to their respective journals over a year prior to the earliest possible priority date of the '324 patent. EX1017, ¶¶6-20; *VidStream LLC v. Twitter, Inc.*, 981 F.3d 1060, 1065-66 (Fed. Cir. 2020) (“When there is an established publisher there is a presumption of public accessibility as of the publication date.”); *Weber, Inc. v. Provisur Techs., Inc.*, 92 F.4th 1059, 1067-68 (Fed. Cir. 2024); (“Where, as here, ‘a publication's purpose is dialogue with the intended audience, that purpose indicates public accessibility.’”) *Microsoft Corp. v. Bradium Tech. LLC*, IPR2016-00448, Paper 9 at 13-14 (PTAB July 25, 2016) (journal articles “are distributed widely and intended to be accessible to the public”). For example, Henke was available from the University of Michigan library and directly from the International Journal of Online Engineering at least by August 1, 2008. EX1017, ¶¶14-20.

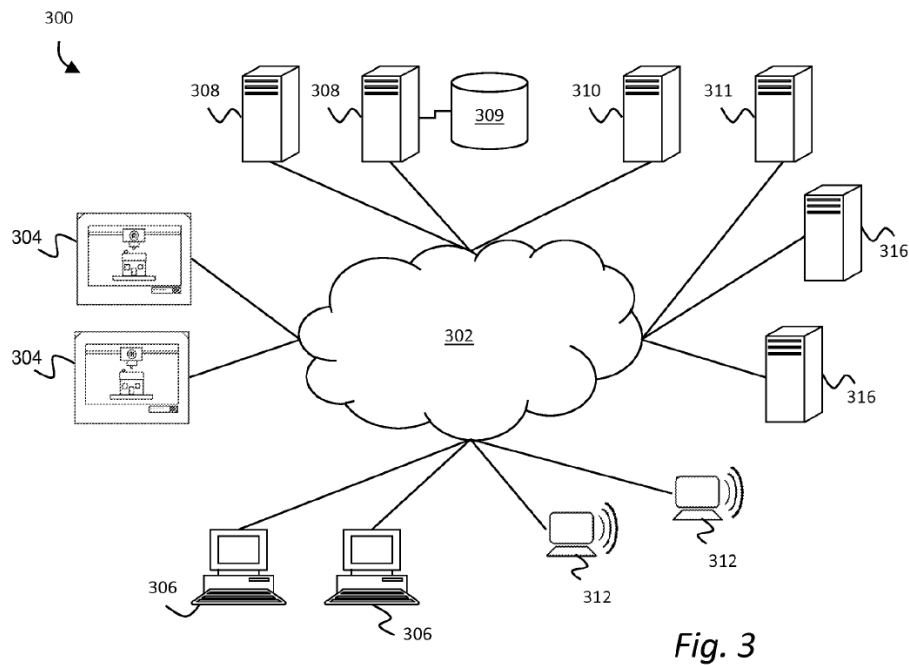
II. SUMMARY OF THE '324 PATENT

A. Brief Description

The '324 Patent describes employing “[w]eb-based servers” to “provide a single point of access for remote users” to “manage use of distributed fabrication resources.” EX1001, 1:32-38; EX1003, ¶¶43-47. The system includes a three-dimensional printer having a build platform, an extruder, a positioning assembly, and a controller. *Id.*, 2:17-26. The printer extrudes build material “at a controlled volumetric rate” to fabricate a three-dimensional object. *Id.*, 4:14-32.

In the preferred embodiment, the printer includes a “video camera” to “provide a remote video feed through the network interface 136, which feed may be available to remote users through a user interface maintained by, e.g., remote hardware.” *Id.*, 6:21-33, 6:61-7:17. The printer can also include “a three-dimensional scanner” to “extract three-dimensional information from the working volume.” *Id.*, 6:34-50.

The three-dimensional printers 304 are within communication with various client and other devices through a network. *Id.*, 8:7-15.



EX1001, FIG. 3.

In this networked system, each remote client device 306 “generally provides a user interface, which may include a graphical user interface and/or text or command line interface to control operation of remote three-dimensional printers 304.” EX1001, 8:54-58, 16:40-42. Upon completion, the system can “notify[] the requester of a successful print job.” *Id.*, 20:15-31. “[T]he status information may include at least one photograph captured, e.g., from a video camera.” *Id.*

The client device can display a user interface “served by one of the three-dimensional printers” that “displays information for a currently active print job.” EX1001, 21:18-25, 22:30-31. The user interface can “display[] a visual representation of the print job.” *Id.*, 22:41-60.

B. Summary of the Prosecution History of the '324 Patent

The '324 Patent was allowed after a terse examination that included a single anticipation rejection of the independent claims. EX1002, 91-197. After the initial rejection, the applicant argued that the prior art (Taminger):

does not teach or suggest any processor that provides an interface to a remote user that include *both* an image from a camera *and* a two-dimensional rendering of a model from the point of view of the camera.

EX1002, 160-162 (emphasis added). According to the applicant, a user interface with images from a video camera alone was not enough. The examiner apparently agreed, allowing the claims while noting that Taminger taught all elements except:

presenting [in] the user interface an image of the build volume from the video camera *and* a two-dimensional projection of the three-dimensional model from the point of view of the video camera.

EX1002, 174 (emphasis added). The '324 Patent was improvidently granted shortly thereafter. The '324 Patent is ripe for review, especially in light of Patent Owner's recent shift in its view of the claim scope.¹

¹ Patent Owner now contends in district court that both the required "image of the build volume from the video camera" and the required "two-dimensional projection of the three-dimensional model" merely encompass images captured by the video camera alone. EX1016, 41-44, *see generally* EX1016, 41-105.

III. LEVEL OF ORDINARY SKILL

A person of ordinary skill in the art (“POSITA”) relating to the subject matter of the ’324 Patent would have had a bachelor’s degree in Mechanical Engineering, Computer Engineering, Electrical Engineering, Materials Science, or a comparable field and at least two years of experience related to 3D printers including remote control of rapid fabrication systems. EX1003, ¶¶40-42. Additional years of experience could substitute for an advanced-level degree (and vice versa). *Id.*

IV. CLAIM CONSTRUCTION

All claim terms should be construed according to the *Phillips* standard. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. §42.100. Here, given the noticeable overlap between the preferred embodiment of the ’324 Patent and the prior art/predictable combinations articulated in Grounds 1A-2G, Petitioners submit that no claim elements need a formal construction for purposes of resolving controversies in this proceeding. *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011); *Google Inc. v. Intellectual Ventures II LLC*, 701 Fed. Appx. 946, 956 (Fed. Cir. 2017) (“do not require construction” for purposes of “resolv[ing] the parties’ patentability arguments”).

V. DETAILED EXPLANATION OF GROUNDS

A. GROUND 1A: Mazumder-Mori renders obvious claims 1, 3, 5-7, 9-10, and 19-22

1. Mazumder

Mazumder describes a system for “remotely controlling the fabrication of a product at a local manufacturing site” that “is fabricated by depositing successive material layers.” EX1004, Abstract, 1:62-2:2 (“direct material deposition” manufacturing), 1:10-13); EX1003, ¶¶48-51. The remote computer can monitor, control and modify the fabrication of the product “in real time” and from a remote location. EX1004, 1:16-20, 2:13-42.

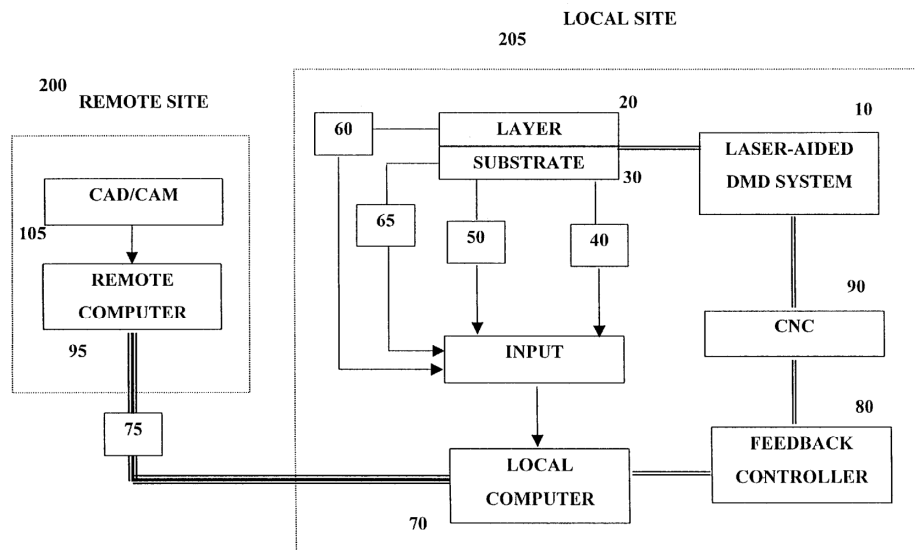


FIG - 1

Id., FIG. 1, 3:26-63. Images of the fabrication process captured by a “video or television camera” are shown in real-time on “the remote computer monitor as streaming video.” *Id.*, 6:36-55, 2:13-42, 8:51-54, Abstract, FIGS. 1-2.

A user interface displayed at the remote computer includes “image and video observation of the laser-aided direct material deposition process.” *Id.*, 2:27-30, 6:36-55. The remote computer allows “the designer [to] pause or abort the

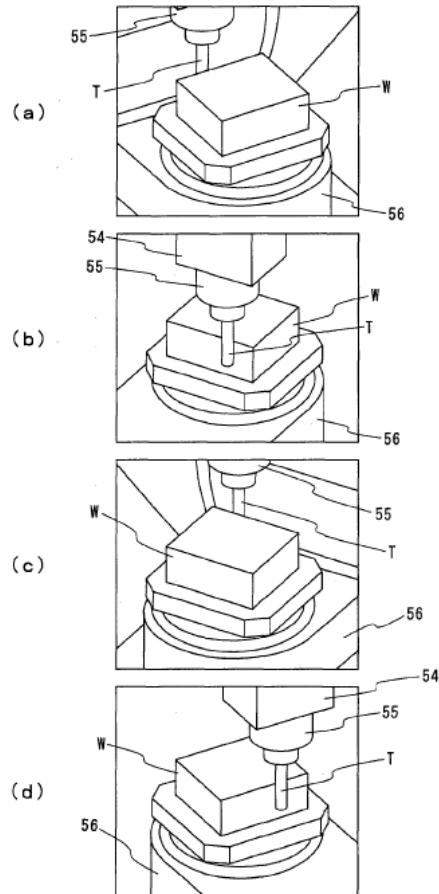
fabrication process by sending a command to the controller” of the system. *Id.*, 2:34-42, 6:44-67. The designer uses the remote computer to provide “design (CAD) files of the product...to the local computer.” *Id.*, 4:18-29. The local computer at the location of the 3D printer “receives instructions from the remote computer 95 to control the deposition process and, if necessary, to alter the entire laser source path or parts of it.” *Id.*, 4:30-37.

2. *Mori*

Mori describes a “machine status monitoring apparatus” for a machine tool that fabricates a “workpiece of [a] three-dimensional model.” EX1005, Abstract, [0001]; EX1003, ¶¶52-57. Mori’s machine tool 50 includes a bed 51 for holding a “workpiece W” and “a control device 62 for controlling the operations” of the machine tool. EX1005, [0044].

Mori’s system further includes “a machining status monitoring apparatus 1” having “a plurality of actual CCD cameras” to “generate two-dimensional image data (actual image data) thereof” as shown in FIG. 4. EX1005, [0043], [0049]-[0050].

Fig. 4



EX1005, FIG. 4.

Mori further suggests a “virtual image generating section 18” that provides views of the workpiece and work environment based on the stored model of the workpiece. EX1005, [0059]-[0065]. For example, “[t]he virtual image generating section 18 generates two-dimensional image data (virtual image data) of, for example, the tool T, workpiece W and a part of the table 56 by a computer process based on the parameters stored in the camera parameter storage section 15 and the model data updated by the model data updating section 17.” *Id.*, [0059]. As such,

the system displays virtual images of the model as if captured from “virtual CCD cameras” that “are respectively arranged at the *same positions* and in the *same orientations* as the actual CCD cameras.”² *Id.*, [0061]-[0062]. “Thereafter, the virtual image generating section 18 in turn generates two-dimensional image data which is assumed to be obtained when the tool T, workpiece W and a part of the table 56 which are represented by three-dimensional model are imaged at a certain time interval by the virtual CCD cameras 19, 20, 21 and 22, and transmits the generated two-dimensional image data to the display control section 23.” *Id.*, [0063].

3. *The Mazumder-Mori Combination*

Multiple reasons would have prompted a POSITA to apply Mori’s suggestions to Mazumder’s system to provide *both* actual images of the object being fabricated as captured by one or more cameras (as expressly disclosed by Mazumder) *and* virtual images of the object generated from stored model data shown from the perspective of one or more virtual cameras (as suggested by Mori), which would have led to several predictable benefits articulated below. EX1003, ¶¶84-89. This predictable combination is especially true in the context of the time frame leading up to 2010 (years after Mazumder’s original disclosure), in which

² All emphasis added unless otherwise noted.

the conventional technology for three-dimensional fabrication systems and computer transfer of video/imaging data was even more sophisticated. EX1003, ¶¶84, 88.

First, presenting the user of Mazumder's remote computer with both actual images of the object and virtual images generated from the model would have advantageously allowed the user to easily visually compare "visual images of the product being fabricated" with virtual images of "three-dimensional models of the...workpiece W" and thereby promptly identify whether the fabrication process is proceeding as planned. EX1004, 7:27-28; EX1005, [0061]-[0062]; EX1003, ¶85. In this predictable combination, providing such an onscreen comparison of the actual object and the model would have enabled the user to better identify "a defect" or "abnormality" and make corresponding adjustments to the model. EX1004, 2:34-42, 6:24-35; EX1003, ¶85; (citing EX1014, 5).

Second, displaying a virtual image of the object being manufactured from the same viewing angle as the actual image of the object (as suggested by Mori) would have allowed the user to of the remote computer to monitor the progress of the object even when the actual view of the object is partially or totally obscured. EX1003, ¶86. For example, the material deposition head/extruder or another part of the rapid fabrication device, or a printed support structure, may temporarily partially or completely obscure the camera's view of the object. *Id.* Displaying a

virtual view of the object from the same angle would have beneficially allowed the user to “always visually recognize the machining status” of the object being fabricated even when the actual view is partially or completely obscured. EX1005, [0083]; EX1003, ¶86.

Third, a POSITA would have recognized that additional virtual views suggested by Mori, including sectional images showing cross sectional representations of the object, would have been helpful because such additional views cannot be obtained from a video camera alone. EX1005, [0074]-[0076]; EX1003, ¶87. Such displaying of a virtual image of the object (from the same perspective as the actual camera) would allow the user to observe progress of inner or rear portions of the object that may not be visible from the angle of the actual camera. EX1003, ¶87.

Finally, such a modification to Mazumder’s system based on Mori’s suggested techniques would have been merely the application of known techniques to a known system ready for improvement to yield predictable results. EX1003, ¶88; EX1005, [0060]-[0061], [0077]-[0079]; *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007). Here, the systems of Mazumder and Mori are each directed to “three-dimensional fabrication” systems, which is the same field identified in the ’324 patent. EX1001, 1:14-20. Mazumder discloses that similar computer-aided manufacturing software is used for additive “deposition” manufacturing and

“conventional CNC machining” involving material removal. EX1004, 2:3-13, 3:47-50. In this context, a POSITA was not an automaton and instead would have possessed ample skill to successfully implement the combination as described above and thus would have reasonably expected success achieving the combination. EX1003, ¶¶84-88.

4. *Application to Challenged Claims 1, 3, 5-7, 9-10, and 19-22*

Element [1.pre]

To the extent the preamble is treated as a limitation (which Petitioner does not concede), Mazumder discloses a device that provides a manufacturing system at a local site 205 for fabrication of a product. EX1004, FIG. 1, 3:3-39 (“[t]he manufacturing system at the local site includes...”), 2:3-13, 2:61-62 (“subsystems”), 7:5-12, 7:39-51; EX1003, ¶¶90, 48-51. Mazumder discloses that all functions of the local site system are “coordinated by the local computer 70.” EX1004, 4:32-38. To the extent that Patent Owner contends that the preamble is a limitation and that Mazumder’s “local manufacturing system” is not expressly described as a “device,” the evidence here confirms that it would have been obvious and beneficial to integrate the components of the manufacturing system at the local site 205 into a device because those subsystems are all collectively dedicated to the three-dimensional fabrication of a “product” using direct material

deposition. EX1004, FIG. 1, 3:25-39, 4:7-10, 7:5-12, 7:39-51; EX1003, ¶90. By the relatively late time frame leading up to 2010, a POSITA would have readily recognized that such a predictable configuration of Mazumder's local subsystems depicted in FIG. 1 would have allowed for easier transportation and installation of the local site portion of Mazumder's system. EX1003, ¶90.

Element [1.a]

Mazumder's system includes "a laser-aided, computer-controlled direct material deposition system 10, which is used to fabricate, repair or modify three-dimensional products by applying sequentially layers of material 20 on a substrate 30." EX1004, 3:11-25, 7:39-51, 1:62-2:2, 1:10-13, FIG. 1. The substrate (and the work space immediately above) is a build volume. EX1004, 4:7-10, EX1003, ¶¶91-92.

Element [1.b]

Mazumder describes that the remote site 200 communicates with the local site 205 via a communications system 75, "preferably including the Internet." EX1004, 3:5-7, FIGs. 1-2. For example, "[t]he local computer 70 communicates with a remote computer 95 via the communication system 75 and receives the necessary computer files defining the deposition tool path for the numerical controller (CNC) 90." EX1004, 3:36-39.

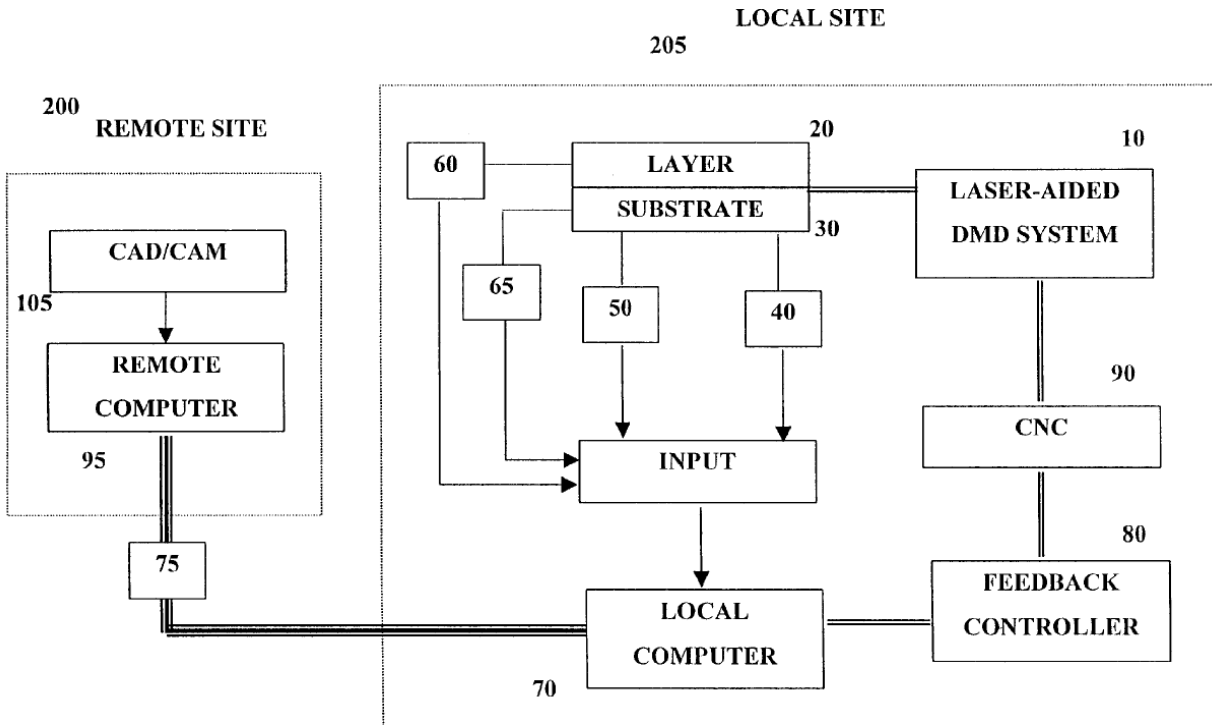


FIG - 1

EX1004, FIG. 1. Mazumder's solution "utilizes advances in telecommunications" "including the Internet" using "high-speed links in asynchronous transfer mode (ATM) or using Ethernet and Fast-Ethernet in a Local Access Network (LAN) or Wide Access Network (WAN) environment." EX1004, 1:62-2:2, 1:24-35. Thus, based on Mazumder's teaching for the bi-directional network communication between the local manufacturing system and the remote computer, Mazumder discloses or plainly suggests that the local computer 70 of the manufacturing system included a conventional network interface to achieve such connectivity via the Internet. EX1003, ¶¶93-94; EX1004, 3:5-7, 3:36-39.

Alternatively, even if Mazumder's teaching did not disclose the use of a conventional network interface, it would have been obvious to implement Mazumder's local computer 70 to include an ordinary network interface at the time so as to advantageously achieve Mazumder's suggestions for "fast data transfer," "fast transmission, e.g., over the Internet," and "fast communication connections" as such network interfaces were well-known, widely-available off-the-shelf components that would have been straightforward to integrate into Mazumder's local computer to facilitate such communication. EX1003, ¶95 (citing EX1004, 6:36-55 ("all processed through the local computer 70, which communicates with the remote computer"), 7:59-61).

Element [1.c]

The sensors at Mazumder's local site include "video or television camera 65." EX1004, 3:26-31, 6:36-55, Abstract; EX1003, ¶¶96-97. The "video or TV camera 65 records the laser-aided DMD process and transmits the images to the local computer 70." EX1004, 6:36-55, *see also* 8:13-17, 8:51-54, 7:26-28, FIG. 1; EX1005, [0049]-[0050].

Element [1.d]

Mazumder discloses that the local computer 70 controls the functions of the subsystems at the local site 205, and a POSITA would have recognized that such a local computer 70 would have included a conventional computer processor for carrying out the described computer functionality. EX1004, 4:32-38; 6:18-23, 6:36-53, 7:44-50, 7:58-61; EX1003, ¶¶98-115. For example, Mazumder describes that “[a]ll these functions are *coordinated by the local computer 70*, which sends feedback data to the remote computer 42 and receives instructions from the remote computer 95 to *control the deposition process*.” EX1004, 4:32-38; EX1003, ¶98. Mazumder further describes that local computer “sends appropriate commands to a feedback controller 80, which interfaces with the numerical controller 90” to control the fabrication process. EX1004, 6:18-23. Furthermore, all recorded sensor information (including video images) “are all processed through the local computer 70.” *Id.*, 6:36-53.

Regarding the functional recitations of Element [1.d], Mazumder discloses that the processor (of the local computer 70) receives a three-dimensional model through the network interface connected to the network (communications system 75). EX1003, ¶¶99-102. Mazumder describes that the user of the remote computer 95 uses “computer-aided design/computer-aided manufacturing (CAD/CAM) software” to generate a model “of the product to be manufactured at the local site 205.” EX1004, 3:40-56; 4:44-49, 2:14-23. The “CAD/CAM data” is received at

the local site and “decompressed and applied to the DMD system.” *Id.*, 3:57-63.

Specifically, “the CAM file of the product description” is “transmit[t]ed, e.g. over the Internet, to the manufacturing site.” *Id.*, 2:24-43. A POSITA would have recognized that “the CAM file of the product description” for a “three-dimensional product[]” provides, or at least renders obvious, a three-dimensional model.

EX1004, 3:11-15; EX1003, ¶100. In another example “the CAD files are simply transmitted to the local computer 70.” EX1004, 6:60-67. A POSITA would have further recognized that this transmission occurs via the network interface of the computer 70 in the predictable combination, as detailed above in Element [1.b]. EX1003, ¶101.

In another example, “[t]he local computer 70 communicates with a remote computer 95 via the communication system 75 and receives the necessary computer files defining the deposition tool path for the numerical controller (CNC) 90.” EX1004, 3:36-56. To the extent that Patent Owner alleges Mazumder’s disclosure of transmitting the “CAM file of the product description” or that “the CAD files are simply transmitted to the local computer 70” does not disclose receiving a three-dimensional model through the network interface, it would have been obvious to modify this second example of Mazumder to generate the deposition tool path at the local computer rather than the remote computer. EX1004, 3:11-15, 6:60-67; EX1003, ¶102. A POSITA would have recognized that

such a modification would have advantageously allowed for a wider variety of devices to serve as the remote computer (including, by 2010, smartphones) because the processing capacity necessary to generate the tool path would not be necessary in the remote device. EX1003, ¶102. Furthermore, this would eliminate the complexity or requirements for the remote user to install special tool path generation software on their device. *Id.* As such, it would have been obvious to transmit the CAD file of “[t]he geometry of the product to be manufactured” to the local computer (via the network interface) to allow the local computer to generate the tool path from the CAD file. EX1004, 3:40-56; EX1003, ¶102.

The processor of Mazumder’s local computer is also configured to control operation of the three-dimensional printer to fabricate the model. EX1003, ¶¶103-104. For example, the “CAD/CAM data” received at the local computer 70 (described above) is then “applied to the DMD system” via the network interface to the feedback controller 80 and numerical controller 90 to fabricate the product using the direct material deposition system. EX1004, 3:57-4:7, 6:21-23. Again, Mazumder teaches these functions of the various subsystems are all “coordinated by the local computer 70.” EX1004, 4:29-38; 6:18-23, 6:36-53; EX1003, ¶¶103-104. Mazumder’s system deposits the material to generate the product on the substrate and therefore the object is fabricated within the build volume. EX1004, 3:11-25, 4:8-37; EX1003, ¶104.

The processor of Mazumder's local computer further provides a user interface including an image of the build volume from the video camera to the remote user. EX1003, ¶¶105-108. Mazumder's "camera 65 records the laser-aided DMD process" and the local computer transmits the images "to the remote computer 95 to be displayed." EX1004, 6:36-43, 8:14-17, 8:51-54. In one configuration, the combined video and sensor data is displayed on a "TV screen" (i.e., a display device that does not include its own computing capability) which indicates that the user interface showing this video information would have been generated by the local computer. EX1003, ¶106. This is especially true given that Mazumder discloses that "temperature, strain and stress data, visual images or metrological information collected at the local manufacturing site 205 are all processed through the local computer 70." EX1004, 6:44-48.

The fact that the designer interacts with the local computer 70 via a web browser of the remote computer further indicates that the local computer 70 generates and provides the user interface, or at least that it would have been obvious to configure the local computer 70 to do so. Mazumder describes a "communications link" from the remote computer to the local computer and that "a user interfaces to the communications link *through an Internet browser.*" *Id.*, 7:12-17, 7:36-38, 8:18-20. A POSITA would have recognized that it is the local computer's processor that produces the user interface for display in such a generic

“Internet browser” of the remote computer. EX1004,; EX1003, ¶107. Patent Owner asserts that this claim feature encompasses “software or firmware to collect image content” and therefore Mazumder’s disclosure of transmitting image content would satisfy this claim. EX1016, 39; EX1003, ¶107. Alternatively, it would have been obvious to implement the Mazumder-Mori system to generate the user interface at the local computer processor to allow the sensor information and video image data to be viewed using a generic web browser, especially in light of Mazumder’s suggestion that all sensor and video data processing should be performed at the local computer. EX1003, ¶108; EX1004, 6:44-55. In such an implementation, the remote user would have beneficially viewed the user interface through a generic web browser rather than requiring installation of specialized software on the remote computer. *Id.*

Regarding the claimed “two-dimensional projection” and “image of the build volume from the video camera,” the Mazumder-Mori combination would have predictably provided both types of images in the user interface for the reasons articulated above. EX1003, ¶¶109-113, 52-57. Mori describes that, similar to the teaching of Mazumder, “a plurality of actual CCD cameras” that “are arranged to surround the workpiece W on the table 56, and are configured so as to be able to image the workpiece W from four directions” to “generate two-dimensional image data (actual image data) thereof.” EX1005, [0043], [0049]-[0050]; EX1003, ¶¶109-

110. And, in addition to the video camera images, Mori further suggests that the resulting Mazumder-Mori system would advantageously include a “virtual image generating section 18” to provide views of the workpiece and work environment based on the stored model of the workpiece. EX1005, [0059]-[0065], [0079]-[0083].³

Mori suggests the benefits of displaying both types of imaging. Mori explains “[t]he virtual image generating section 18 generates two-dimensional image data (virtual image data) of, for example, the tool T, workpiece W and a part of the table 56 by a computer process based on the parameters stored in the camera parameter storage section 15 and the model data updated by the model data updating section 17.” *Id.*, [0059]. As such, the system displays virtual images of the model as if captured from “virtual CCD cameras” that “are respectively

³ Alternatively, Patent Owner contends in the district court litigation that both the required “image of the build volume from the video camera” and the required “two-dimensional projection of the three-dimensional model” are fulfilled by merely displaying images captured by a video camera alone (EX1016, 42-105), in which case Mazumder’s disclosure of video images (“displayed preferably on a TV screen or shown on the remote computer monitor as streaming video”) satisfies both of these requirements. EX1004, 6:36-43, 8:14-17; EX1003, ¶114.

arranged at the *same positions* and in the *same orientations* as the actual CCD cameras.” *Id.*, [0061]-[0062]. “Thereafter, the virtual image generating section 18 in turn generates two-dimensional image data which is assumed to be obtained when the tool T, workpiece W and a part of the table 56 which are represented by three-dimensional model are imaged at a certain time interval by the virtual CCD cameras 19, 20, 21 and 22, and transmits the generated two-dimensional image data to the display control section 23.” *Id.*, [0063]. Mori describes that the user interface displays the actual image data from the actual CCD cameras, the virtual image data, and the sectional image data showing a virtual cross section of the workpiece. EX1005, [0070], [0074]-[0076], FIGs. 4, 7, 10. As such, in the Mazumder-Mori system, the user interface generated by the local computer and provided to the remote computer for display includes both actual images of the volume and a two-dimensional projection of the three-dimensional model “arranged at the *same positions* and in the *same orientations*.” EX1005, [0061]-[0062]; EX1003, ¶¶109-112.

Furthermore, although not required by the claim language, it would have been obvious to display the actual image and the virtual image of the product simultaneously so as to achieve the advantages articulated above. Namely, the presentation of both image types would have beneficially aided the remote user to more easily visually compare the actual image and virtual image to quickly

identify any defects or problems with the fabrication process. EX1003, ¶113.

Indeed, this is consistent with both Mazumder's goals and Mori's suggested benefits. EX1003, ¶113.

Finally, to the extent that Patent Owner contends this "processor" element is not provided by Mazumder's local computer processor "coordinating" all functions of other subsystems (col. 4:29-38), such a minor difference is inconsistent with Patent Owner's contentions in the district court⁴ and "is not a distinction on which validity turns." *See Smith & Nephew, Inc. v. Rea*, 721 F.3d 1371, 1378 (Fed. Cir. 2013). The evidence here confirms that a POSITA would have recognized, due to improvements in computing capacity of processors during the decade between the 1999 priority date of Mazumder and the August 2010 priority date of the '324 patent, it would have been obvious and beneficial to implement the processing and control functions of the local computer 70, the feedback controller, 80 and the CNC 90 using a single processor. EX1003, ¶115. Such an implementation would have reduced the number of components required for the device thereby reducing the overall footprint and improved efficiency by eliminating the need for

⁴ Patent Owner contends in the district court litigation that this "processor" element is encompassed by a system performing the recited functions using both a first processor and a separate master control unit. EX1016, 24-25.

communication between disparate processors within the resulting device. *Id.*

Additionally, utilization of a single processor would have allowed for changes and improvements to be made to the system through software updates to software installed on a single processor rather than requiring different software updates for different components of the system. *Id.*

Claim [3]

Mori discloses that the virtual image is generated based on “the model data updated by the model data updating section 17.” EX1005, [0059]-[0060], [0079]. Mori goes on to disclose that “the ***model data storage section 16 is updated*** by the model data updating section 17 ***synchronously with the actual operations***” of the fabrication system. *Id.*, [0078], [0053]-[0059]. As such, in the predictable Mazumder-Mori combination, the virtual image is simulated based upon operation of the three-dimensional printer of Mazumder. EX1003, ¶116.

Alternatively, Patent Owner contends in the district court litigation that this claim encompasses merely displaying video camera images of the product at a remote computer (EX1016, 57-66), in which case Mazumder’s disclosure of displaying the image data of the product at the remote computer also provides this claim. EX1004, 6:36-43, 8:14-17; EX1003, ¶117.

Claim [5]

Mori discloses that the model data on which the virtual images are based is updated “*synchronously with the actual operations*” of the fabrication system. *Id.*, [0078], [0053]-[0060] (update “the model data of the workpiece W so that this cutting area is removed therefrom.”), [0079]. In the predictable Mazumder-Mori combination, in which the automated manufacturing process is an additive rather than subtractive process, the virtual image is dynamically updated to correspond to a state of the physical completion of the product. EX1003, ¶118.

Alternatively, Patent Owner contends in the district court litigation that this claim encompasses merely displaying video camera images of the product at a remote computer (EX1016, 67-90), in which case Mazumder’s disclosure of displaying the image data of the product at the remote computer also provides this claim. EX1004, 6:36-43, 8:14-17, Abstract; EX1003, ¶119.

Claim [6]

Mazumder describes displaying a video image from the video camera. EX1003, ¶¶120-122. Specifically, “[t]he fabrication process is recorded by video or television camera and...shown in real-time on a screen display connected to the remote computer.” EX1004, Abstract, *see also* 6:36-43, 8:14-17. Patent Owner’s infringement contentions indicate that this claim element encompasses merely displaying a regular image from the video camera. EX1016, 91-105; EX1003, ¶122.

Claim [7]

Mazumder's system allows the "designer interfacing with the ***remote computer*** to monitor, ***control*** and modify the fabrication of the product in real time on line." EX1004, Abstract. The remote designer "operates, ***through a user interface***, their 'remote' host computer." EX1004, 2:14-17. For example "the designer may pause or abort the fabrication process by sending a command to the controller of the DMD System at the 'local', i.e. the manufacturing, site." *Id.*, 2:34-39. Mazumder discloses that the local system "receives instructions from the remote computer 95 to control the deposition process." EX1004, 4:30-41, *see also* 6:30-35, 7:1-18, 7:56-61, 8:36-38; EX1003, ¶¶123-124.

A POSITA would have recognized that Mazumder's description of the remote computer controlling the fabrication process by "sending control commands" indicates that the user interface includes a control for issuing such commands. EX1003, ¶124. Alternatively, it would have been obvious to include one or more controls to facilitate the remote control functionality described by Mazumder. EX1003, ¶124; EX1004, Abstract.

Claim [9]

Mazumder describes, “data from the sensor systems 40, 50, 60 are processed by the local computer to produce real-time temperature, strain and stress data during the fabrication process” and this information is sent “to the remote computer 95 to be displayed” in the user interface. EX1004, 6:24-55, 5:25-36, Abstract. A POSITA would have recognized that at least temperature of the build volume is status information for the three-dimensional printer. EX1003, ¶125.

Claim [10]

Mazumder measures status information “*during the deposition process.*” EX1004, 5:25-36, 6:24-35 (“...produce real-time temperature, strain and stress data during the fabrication process”). The local computer of the local site “sends the images together with the associated temperature, strain and stress data to the remote computer 95 to be displayed.” *Id.*, 6:24-55, Abstract; EX1003, ¶126.

Element [19.pre]

Mazumder discloses “[a] system and method for remotely controlling the fabrication of a product at a local manufacturing site.” EX1004, Abstract, 1:17-21; EX1003, ¶¶127.

Element [19.a]

Mazumder’s local site system 205 is a three-dimensional “direct material deposition” printer that includes a build volume (substrate and workspace immediately above), a network interface for communicating with remote site 200

via communications system 75, and a video or TV camera 65 for capturing video of the build volume from a point of view. *See* Analysis of Elements [1.a]-[1.c], *supra*; EX1004, 3:5-39, 7:39-51, 1:62-2:2, 1:24-35, 2:23-26, 4:38-48, 6:36-55, 8:13-17, 8:51-54, 7:26-28; FIGs. 1-2; EX1003, ¶¶128-131.

Element [19.b]

See Analysis of Element [1.d], *supra*. EX1003, ¶¶132, 99-102.

Element [19.c]

See Analysis of Element [1.d], *supra*. EX1003, ¶¶133, 103-104.

Element [19.d]

See Analysis of Element [1.d], *supra*. EX1003, ¶¶134-135, 105-113.

Claim [20]

Mazumder discloses that the above described “temperature, strain, and stress data” and video images (Claims [9]-[10], *supra*) are sent “to the remote computer...***in real time*** on line.” EX1004, Abstract, 4:39-41, 6:27-55, 7:56-61, 8:31-38. Mazumder’s system “fabricate[s] ***completed*** parts and products.” EX1004, 4:1-3. Because this status information is continuously sent to the remote computer over the data network (e.g., the Internet) for display in the user interface, a POSITA would have recognized that this information is transmitted both during the fabrication process and upon completion of the product. EX1003, ¶¶136-137.

Claim [21]

Mazumder discloses that the local computer “sends the images together with the associated temperature, strain and stress data to the remote computer 95 to be displayed.” EX1004, 6:24-55, Abstract. As discussed with respect to Element [1.d], *supra*, this status information would have been displayed as part of the user interface. EX1003, ¶138.

Claim [22]

See Analysis of Element [1.d] and Claims [6], [20]-[21]. EX1003, ¶¶139-141. According the Patent Owner’s infringement contentions, the same image that satisfies Elements [1.d] and [19.d] also satisfy this claim. EX1016, 187-189.

B. GROUND 1B: Mazumder-Mori-Tian renders obvious claim 4

Claim [4]

A POSITA would have applied Tian to the Mazumder-Mori system to compare “the actual image data obtained by the first CCD camera 13 and the virtual image data generated to correspond to the first CCD camera 13...to determine whether these image data match.” EX1006, [0100]-[0102]; EX1003, ¶¶147-148, 58-60. Tian describes an automated manufacturing system for making a “workpiece.” EX1006, [0005]-[0007]. Tian describes comparing the workpiece and to a three-dimensional model to “confirm[] easily, efficiently, and precisely whether three-dimensional model data including an attached object attached to a machine tool and at least a part of the machine tool good are accurate.” EX1006,

Abstract. Specifically, Tian compares “the two-dimensional image data related to the actual attached object generated in the actual-image-data generating process and the two-dimensional image data of the attached object related to the three-dimensional model” to determine if the actual object and the model “match.” *Id.*, [0013], [0022], [0025], [0100], [0111]. A POSITA would have applied this teaching to Mazumder-Mori to compare the actual images and virtual images of the object being fabricated. EX1003, ¶¶142-148.

A POSITA would have been prompted to apply Tian’s teaching to the Mazumder-Mori combination to compare the virtual images of the object (derived from model data) with the actual image of the object and adjust the model as a result for multiple reasons. EX1003, ¶¶142-145. **First**, Mazumder is express that it allows the designer to “monitor, control *and modify* the fabrication of the product.” EX1004, Abstract, 3:11-25, 6:24-35. This includes “[m]odification of the CAD and CAM files.” *Id.*, 6:44-55. For example, the remote user can identify “a defect, an abnormality or some other undesirable characteristic affecting the final quality of the product” and subsequently pause or abort the fabrication process to edit the CAD file to improve the design. *Id.*, 2:34-42. A POSITA would have found it beneficial to apply Tian’s teaching to Mazumder-Mori to provide functionality to automate at least part of this defect/abnormality detection to

improve the ability of a user to detect defects/abnormalities. EX1006 [0013], [0022], [0025], [0100]-[0002], [0111]; EX1003, ¶142.

Second, such automated detection and correction of defects through comparison of images of the actual object to the model would have allowed the system to detect defects/abnormalities that would be difficult or impossible for a human to detect through manual, visual comparison, thereby improving the resulting product. EX1003, ¶143.

Third, Mazumder expressly discloses comparing sensor information to “pre-determined failure criteria” to identify defective products/designs. EX1004, 6:10-23. Tian complements this teaching by describing a specific type of sensor data (the object image data already captured by Mazumder) that can be compared to pre-determined data (the model) to identify failure scenarios which can be used to improve the design. EX1006 [0013], [0022], [0025], [0100]-[0002], [0111]; EX1003, ¶144.

Finally, Such a modification would also be the application of known techniques to a known system ready for improvement to yield predictable results. EX1003, ¶145; *KSR*, 550 U.S. 398, 417.

C. GROUND 1C: Mazumder-Mori-Hull renders obvious claim 8

1. Hull

Hull describes a stereolithographic apparatus and method “for forming three-dimensional objects.” EX1008, Face, [0014]-[0017], [0130]. Hull’s system allows a user to design or provide a solid CAD model for the object to be fabricated. *Id.*, [0035]-[0039], [0149]-[0152]. Similar to Mazumder, Hull describes allowing a user to transfer design files from a remote computer to a “process computer” that controls the cabinet assembly of the deposition machine. *Id.*, [0140], [0143]. To access the process computer at the fabrication site, the user at the remote computer logs in as a “Remote user” by entering a “password.” *Id.* [0157]

2. The Mazumder-Mori-Hull Combination

A POSITA would have been prompted to apply Hull’s teaching to the Mazumder-Mori combination to require login credentials, including a password, to access the local computer of Mazumder’s local site from the remote computer, including access to control and status information via the user interface for multiple reasons. EX1003, ¶¶149-154. Requiring credential-based access, including a password, for remote access of the local system (and its user interface), would have prevented unauthorized users from accessing the fabrication system. EX1003, ¶149. This would have prevented unauthorized waste of fabrication time, power usage, and deposition material, thereby freeing up these resources for

authenticated/authorized users and prevented bad actors from sending commands that could damage or disable the system. EX1003, ¶¶150, 152. Credential based access also would have allowed the operators of the local fabrication system to keep track of which remote users have used the system. EX1003, ¶151. It would also be the application of known techniques to a known system ready for improvement to yield predictable results. EX1003, ¶153; *KSR*, 550 U.S. 398, 417.

3. *Application of Mazumder-Mori-Hull to Claim 8*

Claim [8]

Hull discloses that for a “Remote user” to access the local fabrication system, the user must “type your password and press enter.” EX1008, [0157]; EX1003, ¶¶155, 61-62. As discussed with respect to Element [1.d], *supra*, Mazumder discloses, or at least renders obvious, that the user interface is generated and provided by the local site in the Mazumder-Mori-Hull combination and therefore requiring credential-based access to the local site includes requiring the credential-based access to access the user interface provided by the local site. EX1004, 6:36-55, 8:14-17; 7:36-38, 8:18-20; EX1003, ¶¶155, 105-108.

D. GROUND 1D: Mazumder-Mori-Seki render obvious claim 11

I. Seki

Seki describes “a tool path drawing method which facilitates confirmation of the movement of a tool associated with three-dimensional machining.” EX1009,

1:43-46. Seki displays both a three-dimensional and two-dimensional tool path in the user interface as the tool moves in real time display of the workpiece is displayed in a lower portion of the display. *Id.*, 2:24-32. Seki describes that “motion definition statement[s]...give[] instructions for a movement of the tool.” *Id.*, 4:1-8. Furthermore, “[e]very time NC data associated with a motion definition statement is executed, thereafter, one of first to fifth sections of a tool path 7 **which corresponds to this NC data**, along with its preceding tool path section, is drawn on a peripheral surface 2 of the workpiece FIG. 1 which is **drawn on the display screen 25a**.” *Id.*, 2:32-37. This includes drawing the section of the tool path “along with its preceding tool path sections...on the YZ coordinate system” on the display screen. *Id.*, 2:38-43.

2. *The Mazumder-Mori-Seki Combination*

A POSITA would have been prompted to apply Seki’s teaching to the Mazumder-Mori combination to display the tool path of the currently deposited layer as part of the user interface for multiple reasons. EX1003, ¶¶156-161. **First**, displaying the tool path would provide additional information to the remote designer to allow the designer to track the progress of the fabrication process thereby giving the designer a better understanding of the fabrication process in general. EX1003, ¶156. **Second**, displaying the tool path of each layer as its deposited would have given the remote designer additional visual information that

would have allowed the designer to detect defects/abnormalities in the design process such as unanticipated tool motions. EX1003, ¶¶156-157. **Third**, displaying of the two-dimensional tool path would have allowed the remote designer to easily compare the expected movements of the device (as represented by the displayed tool path) to actual movements of the device (as shown in the live camera feed) to identify problems or unexpected motions in the fabrication process that could indicate defects with the fabrication machine itself. EX1003, ¶157. **Fourth**, Seki confirms that displaying both the three-dimensional tool path and two-dimensional tool path as the fabrication device operates makes it easier to confirm correct movement of the tool. EX1009, 1:36-40; EX1003, ¶158. Such confirmation by the operator can allow for correction of the model. EX1009, 4:42-50. This can lead to “no or less errors.” *Id.*, 1:58-2:2.

Finally, Such a modification would also be the application of known techniques to a known system ready for improvement to yield predictable results. EX1003, ¶¶159-160; *KSR*, 550 U.S. 398, 417.

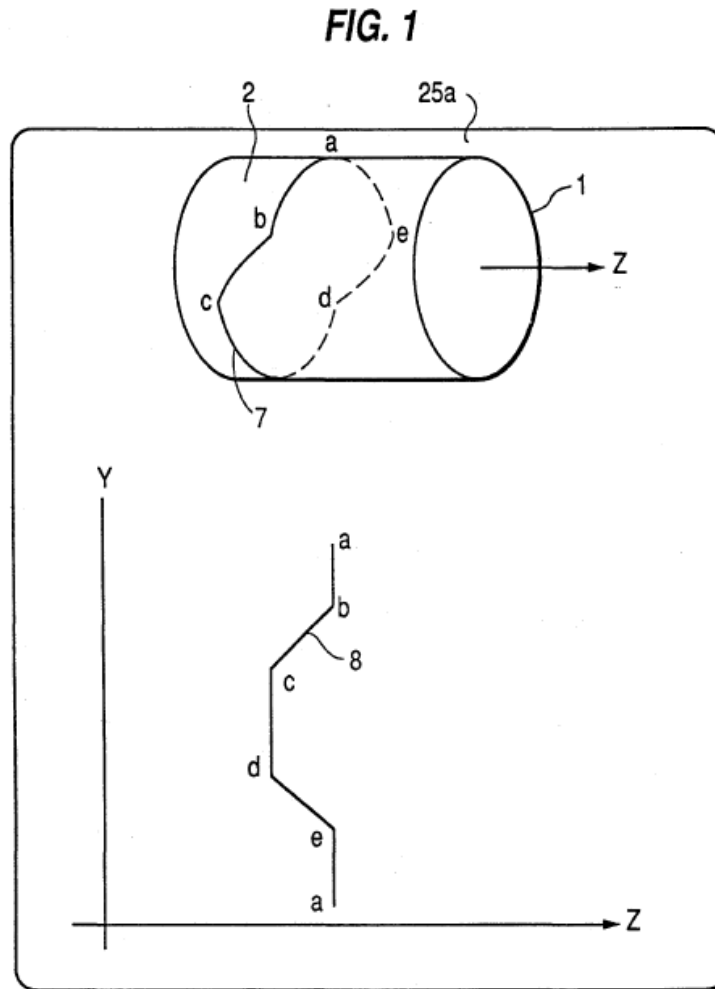
3. *Application of Mazumder-Mori-Seki to Claim 11*

Claim [11]

As discussed above, Mazumder’s fabrication system deposits material according to a tool path. EX1004, 2:3-13, 3:36-39, 4:8-29. Seki discloses displaying both a three-dimensional and two-dimensional tool path as the

machining tool executes “motion definition statement” to move the machine tool.

EX1009, 2:28-43; EX1003, ¶¶162-164, 63.



EX1009, FIG. 1

In another example, Seki describes that when an instruction for machining the workpiece occurs, “the CPU 21 calculates a tool path section” for both the three-dimensional and two-dimensional display and provides the information to the display device such that “the tool path section b'-c' is drawn on the YZ coordinate

system.” EX1009, 4:19-41; EX1003, ¶164. The fact that the tool path segment is displayed to correspond to the real-time movement of the tool indicates that in the resulting system, the displayed tool path is for the current layer. EX1003, ¶164.

E. GROUND 1E: Mazumder-Mori-Waehner renders obvious claim 17

I. Waehner

Waehner describes a system for dual mode digital video recording. EX1010, Face. Waehner describes problems regarding storing large amounts of video data. *Id.*, [0004]. Adding additional memory storage can be difficult and expensive. *Id.* To correct for these problems, Waehner describes a system that allows a user to select from “two separate and different recording modes in the digital video recorder” with one mode “provid[ing] high quality, maximum or high update rate video.” *Id.*, [0009]. “The second mode provides time lapse recording where the various cameras are recorded at a slower rate and, if desired, at a lower resolution” which reduces the storage capacity required, thereby facilitating “archival storage” for later review of video to identify “events that have not been detected and would otherwise be lost.” *Id.*, [0010].

Waehner describes receiving video feeds from multiple digital cameras or digitizing video feeds from multiple analog cameras. EX1010, [0019]. The video data is compressed and stored. *Id.* The system then creates time-lapse versions of

the video for long-term storage by sampling “only one out of every predetermined number of sequential images or frames.” *Id.* This sampling “reduces the number of images per camera per second” to facilitate efficient storage “for a long period of time.” *Id.*

The user of the system controls the sampling through “user input 43” which can take the form of “control buttons” using “a workstation,” “personal computer,” or “laptop computer” to “provid[e] setup information over a network to digital video recorder 18.” EX1010, [0018].

2. *The Mazumder-Mori-Waehner Combination*

A POSITA would have been prompted to apply Waehner’s teaching to the Mazumder-Mori combination to allow users to select a time-lapse recording option and set the sampling rate and other parameters using a user interface for the videos of the fabrication process (as described by Mazumder and Mori) for multiple reasons. EX1003, ¶¶165-170. Such an implementation would have reduced the amount of storage required for the video images captured by the camera(s) of the Mazumder-Mori system. EX1010, [0004], [0019]; EX1003, ¶165. Providing a time-lapse option for the system’s video data would have facilitated long term storage of large amounts of video data without the need to add additional storage capacity. EX1010, [0004], [0010], [0019]-[0020]; EX1003, ¶166. This increased ability to store more video for longer periods of time can allow for later review of

fabrication procedures to identify “events that have not been detected and would otherwise be lost” such as when a defect in an object/design is detected a period of time after the fabrication process has completed. EX1010, [0010]; EX1003, ¶¶167-168. Furthermore, allowing the user to choose between both time-lapse and high resolution, full frame videos would allow for “review[ing] of recent events” with “the maximum amount of information” in the video while providing the storage benefits discussed above. EX1010, [0009]; EX1003, ¶169.

3. *Application of Mazumder-Mori-Waehner to Claim 17*

Claim [17]

In addition to the standard video mode, Waehner describes a “second mode” that “provides time lapse recording video data with lower resolution.” EX1010, [0010]. The time lapse video data can be created by first receiving regular fidelity video data, compressing the data, and sampling the video “so that for each camera only one out of every predetermined number of sequential images or frames” is retained. *Id.*, [0019]. The “predetermined rate” can be “selected by a user.” *Id.* A POSITA would have recognized that this description of Waehner’s time lapse video mode is “stop-motion” animation. EX1003, ¶¶172

Waehner describes that a “user input 43...connected to processor 36” such as “control buttons” implemented on a workstation, personal computer or laptop computer is used to select the video mode (standard or time lapse) and set other

parameters. EX1010, [0018]; EX1003, ¶¶171-172, 64-65. As such, a POSITA would have recognized that in the Mazumder-Mori-Waehner combination, the user interface provided by the local site for display at the remote computer would have included at least one control for capture of the time lapse video (stop-motion animation) of the fabrication process. EX1003, ¶¶171-172.

F. GROUND 1F: Mazumder-Mori-Lan renders obvious claim 18

1. Lan

Lan is a survey paper analyzing several earlier studies on “remote control and monitoring for [Rapid Prototyping] machines.” EX1011, 1-2. This includes “direct access to rapid prototyping facilit[ies] over the Internet.” *Id.*, 2. Some systems include a print server to connect the remote user to an available and appropriate rapid prototyping machine. EX1011, 3-5.

H. Lan/Computers in Industry 60 (2009) 643-656

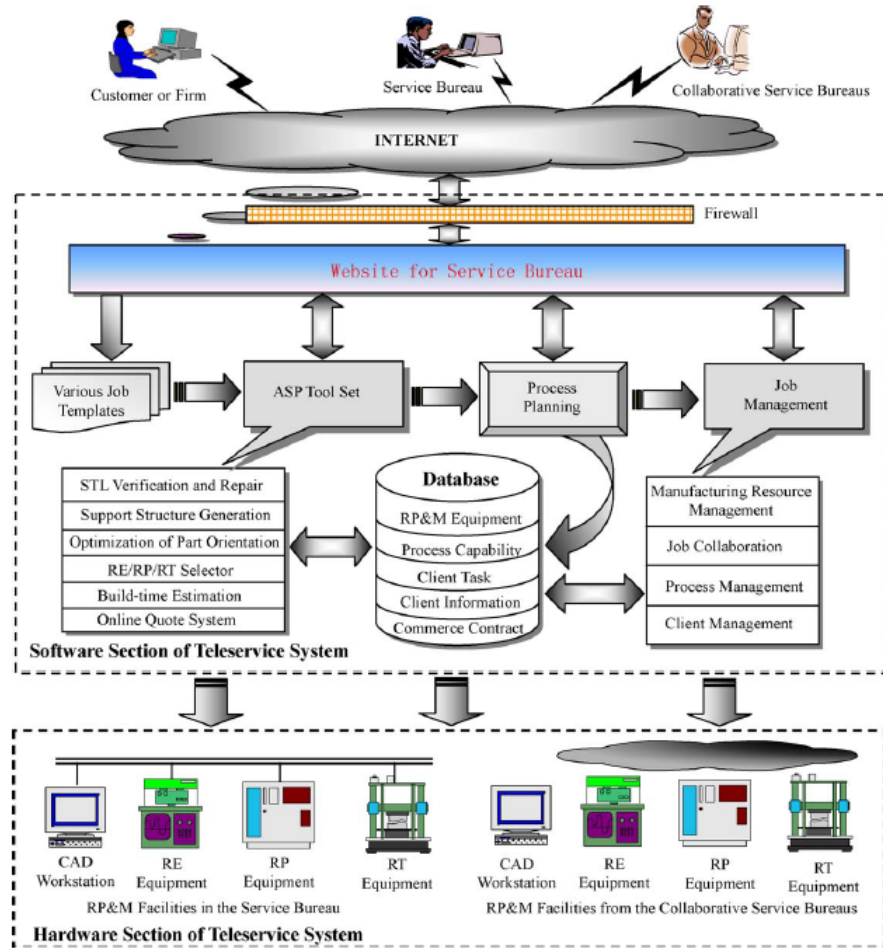


Fig. 4. Architecture of the Web-based RP&M system.

EX1011, 5.

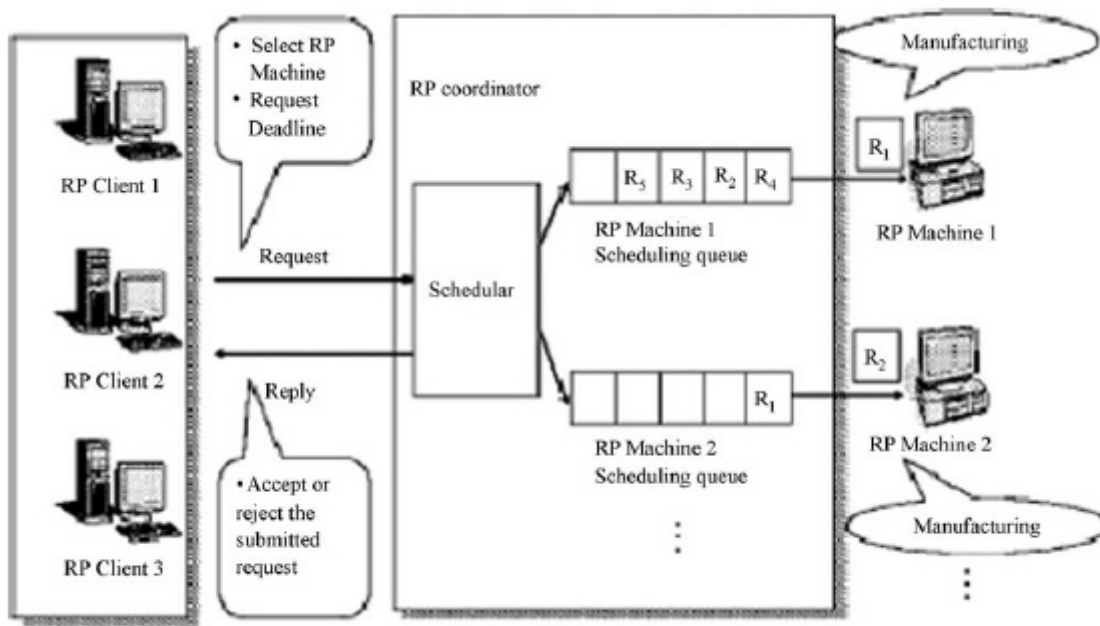


Fig. 10. Distributed RP platform scheduler [65].

EX1011, 10.

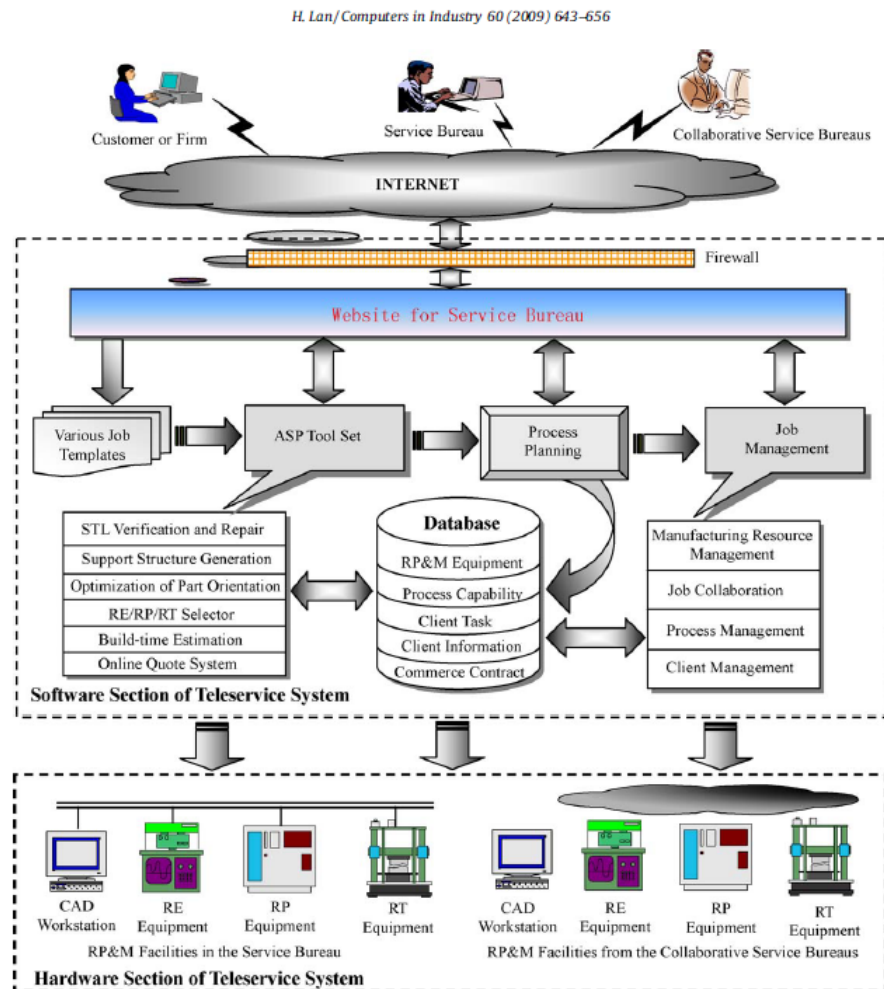
Remote users transmit CAD models (e.g., an STL file) “via the Internet to the RP Web server.” EX1011, 3, 10. The Web server then schedules the fabrication/print job with an available device and “the Web server can transmit the STL file to the RP machine.” *Id.* Similar to Mazumder, “[d]uring manufacturing process, customers also can watch a live image of RP part via Internet, and monitor the RP machine which fabricates physical part through CCD camera.” *Id.*

In another example “a teleservice system for RP service bureaus to support the implementation of the Web-based RP manufacturing” in which remote users connect through the internet to an “information center” which connects users to

rapid fabrication devices and transmits STL files to those devices after verification and repair of the files. EX1011, 3-4, FIG. 4.

2. *The Mazumder-Mori-Lan Combination*

A POSITA would have been prompted to apply Lan's teaching to the Mazumder-Mori combination include a remote print server in communication with the local site three-dimensional printer through the network (e.g., the Internet) for multiple reasons. EX1003, ¶¶173-180. Such an implementation would have allowed for multiple remote users to interface with multiple rapid fabrication devices efficiently and effectively. EX1003, ¶¶173-174. Lan teaches that use of an intermediary web-based print server allows for automated scheduling of rapid fabrication processes "to minimiz[e] idle time" and lower "the effective cost rate." EX1011, 9-10, 3; EX1003, ¶175. As such an "optimal" scheduling solution is achieved in which "new requests can be accepted dynamically and all accepted requests can be finished before deadlines" such that "the quality of service is significant[ly] improved." EX1011, 10, 5; EX1003, ¶176. Such an implementation would also allow remote users to easily access a variety of rapid fabrication devices through a common interface. EX1003, ¶¶177-179.



EX1011, 5. Applying Lan’s teachings to Mazumder-Mori can also allow for automated selection of “a valid and feasible RP manufacturing site” for a given design so that the remote facility having the correct “site manufacturing capability” is selected while meeting “delivery time constraints.” *Id.*, 10; EX1003, ¶¶177-178. This includes automated RP&M process selection. EX1011, 6-8.

Such an implementation would also allow users to select a preferred remote rapid fabrication device. EX1011, 10, 3, 5; EX1003, ¶178.

3. *Application of Mazumder-Mori-Lan to Claim 18*

Claim [18]

In one example system, Lan describes that the user transmits the CAD model (an STL file) “via the Internet to the RP Web server” which then schedules the print job and “transmit[s] the STL file to the RP machine that [is] chosen by the customers.” EX1011, 3. In another example, the web server selects “a valid and feasible RP manufacturing site” for a given design so that the remote facility having the correct “site manufacturing capability” and schedules the print job “to minimiz[e] idle time.” *Id.*, 10. The user provides the STL file to the web server, which queues the print job for the appropriate fabrication machine. *Id.*

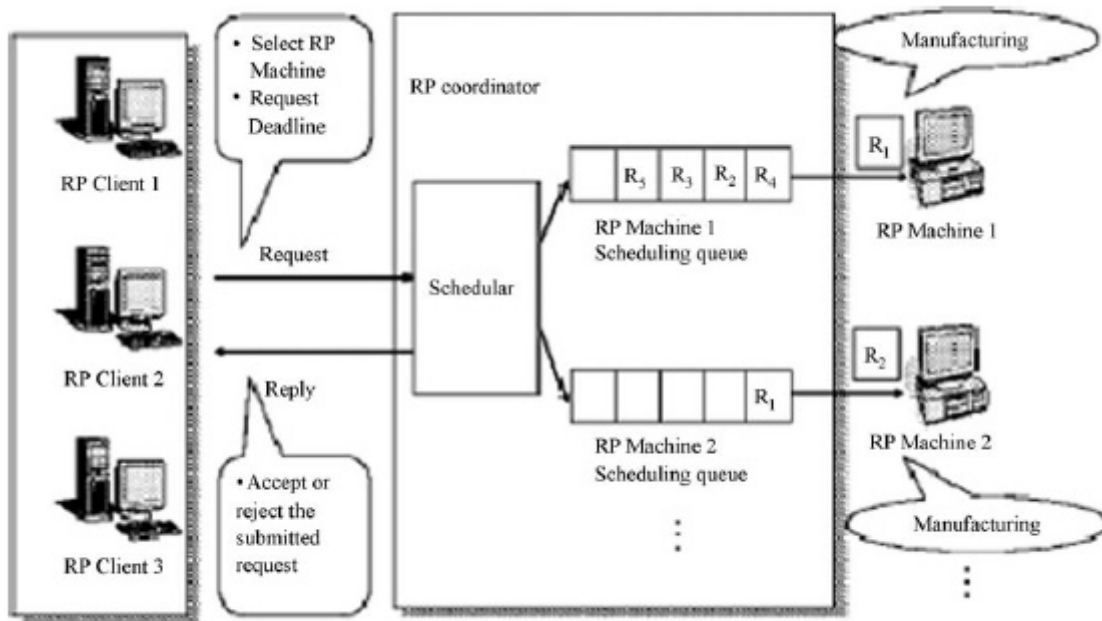
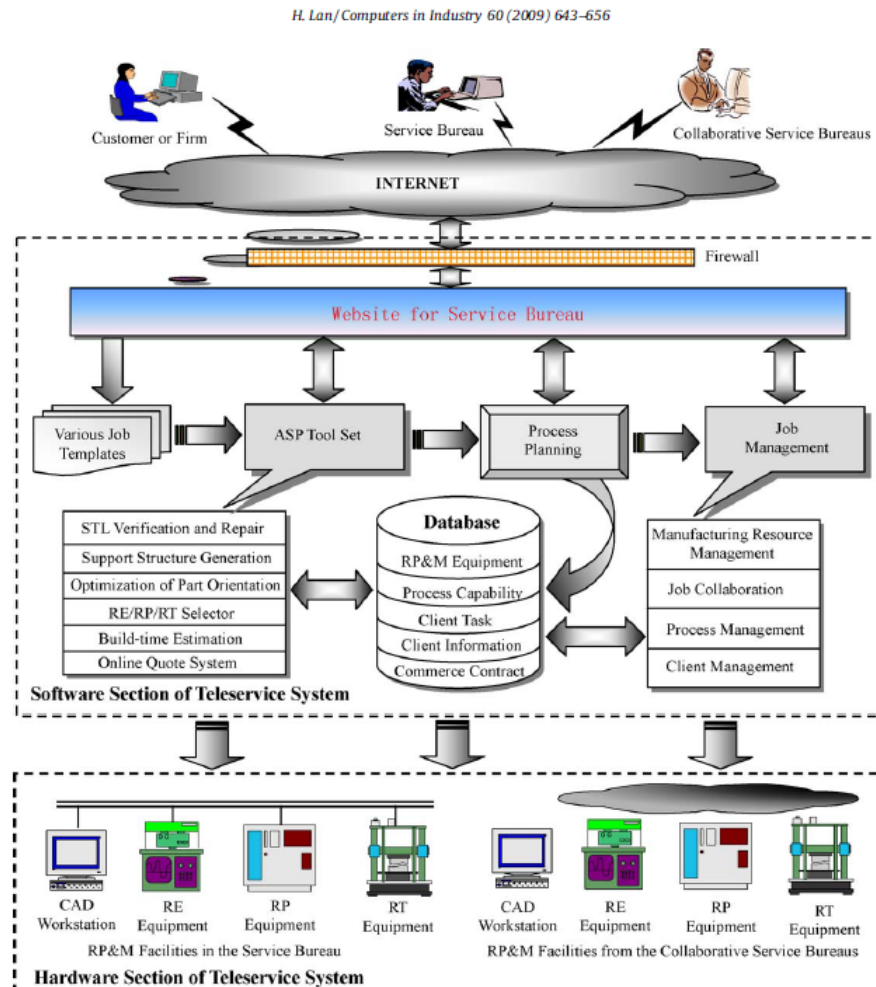


Fig. 10. Distributed RP platform scheduler [65].

EX1011, 10.

Lan teaches that the web server can coordinate print jobs between multiple users and multiple fabrication devices:



EX1011, 5.

A POSITA would have recognized that the web servers described in Lan, which coordinate and schedule rapid fabrication jobs between multiple users and multiple rapid fabrication devices, and provide model data to those devices, meet

the description of a print server in the '324 patent. EX1003, ¶¶181-183, 66-68;
EX1001, 9:4-37.

**G. GROUND 1G: Mazumder-Mori-Anderson renders obvious
claims 20-22**

I. Anderson

Anderson describes “[a] method of providing three-dimensional object fabrication status” including “fabrication progress” and “provid[ing] a visual representation of the three-dimensional object(s) fabrication progress in the form of one or more progressively filled-in wireframe model representations.” EX1012, Abstract, [0015]-[0017].

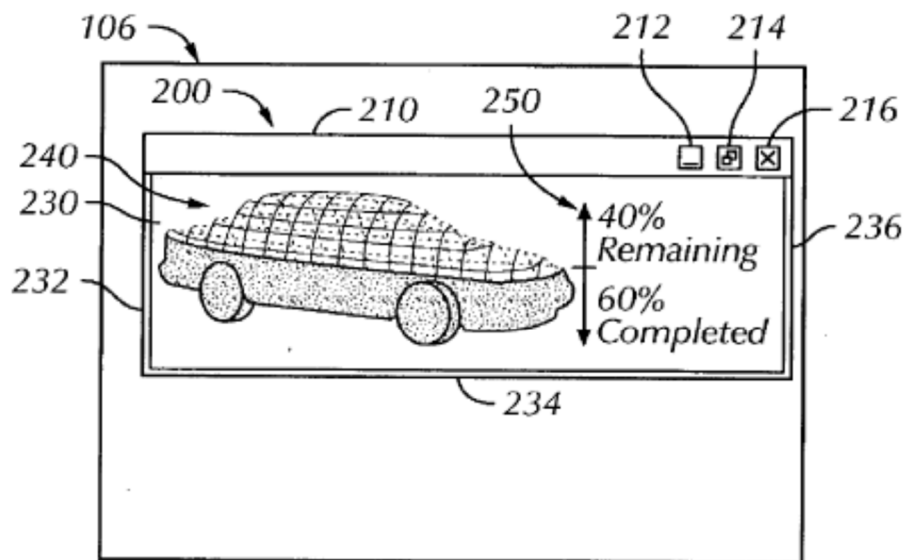


FIG. 2A

EX1012, FIG. 2A.

Status information can also include “the number of passes completed by the printhead,” a numerical percentage of the completion of the object, or an indication of if the object is waiting (in queue), active (printing), or completed. EX1012, [0018]-[0019], FIG. 1.

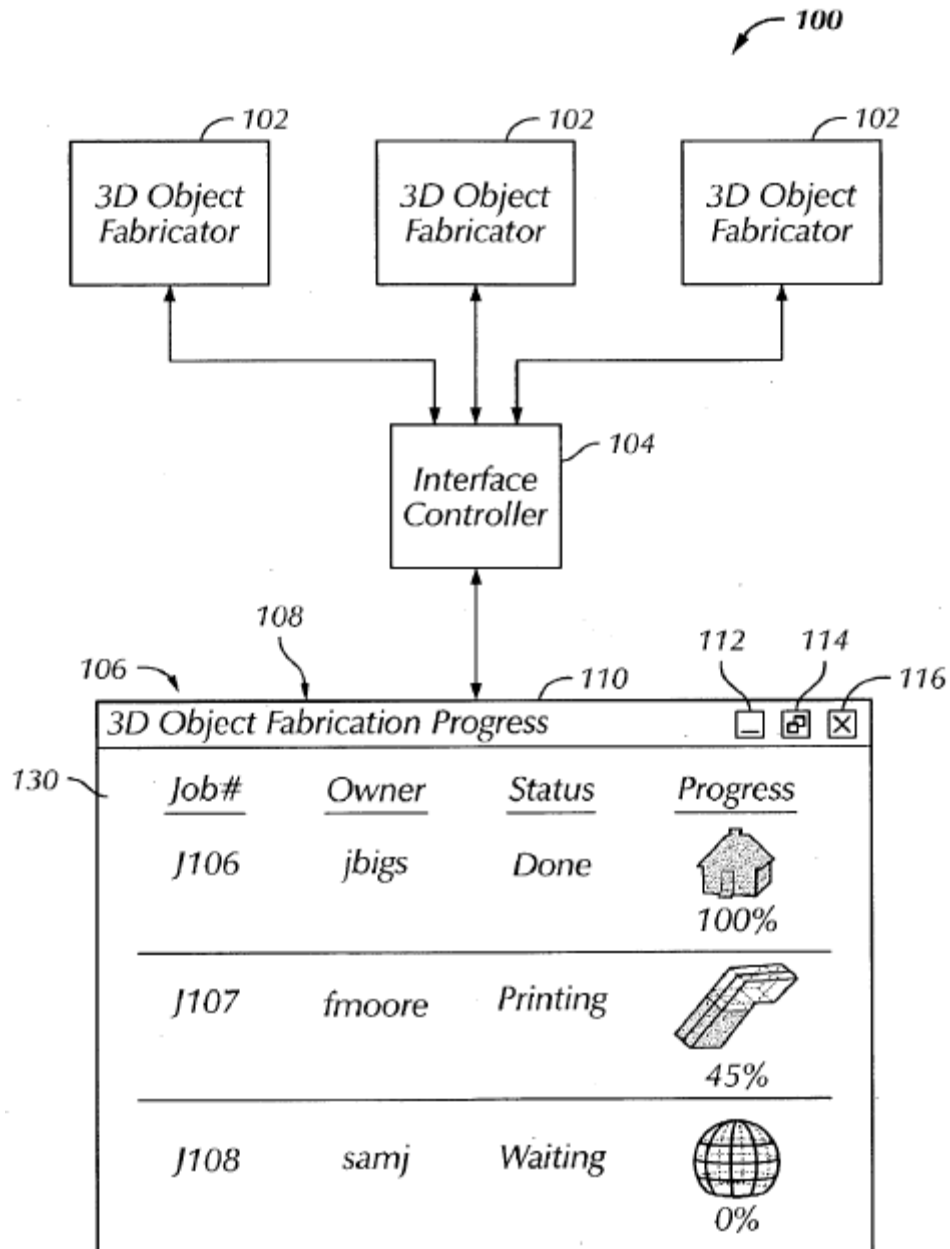


FIG. 1

2. *The Mazumder-Mori-Anderson Combination*

A POSITA would have been prompted to apply Anderson's teaching to the Mazumder-Mori combination to display the above described additional status information in the user interface for multiple reasons. EX1003, ¶¶184-191. **First**, Mori also discloses displaying views of the object generated based on the model. EX1005, [0059]-[0065], [0079]-[0083]. Anderson complements this teaching by providing additional context for the virtual view of the object by showing which layers have been completed with respect to a wireframe of the completed object:

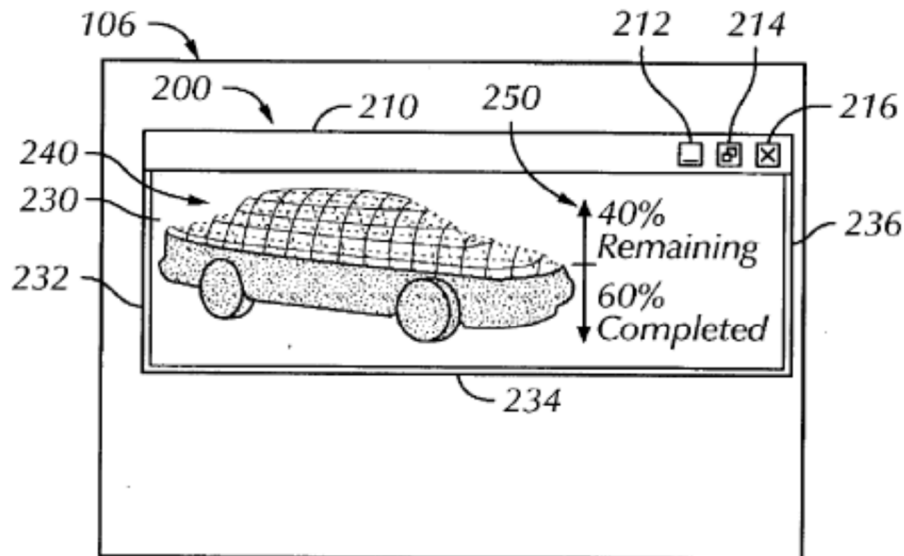


FIG. 2A

EX1012, FIG. 2A, [0018]-[0020]. Such additional context would have increased the user's knowledge and understanding of the overall fabrication process.

EX1003, ¶¶184-186. **Second**, the additional information regarding progress of the

object would help the user to readily assess the progress of the fabrication process and estimate the amount of time remaining. EX1003, ¶187; EX1012, FIG. 1-2A, [0018]-[0020]. **Third**, the additional status information would have allowed users to easily identify where in a print queue the user's particular design is to help the user to better schedule other tasks. EX1003, ¶188.

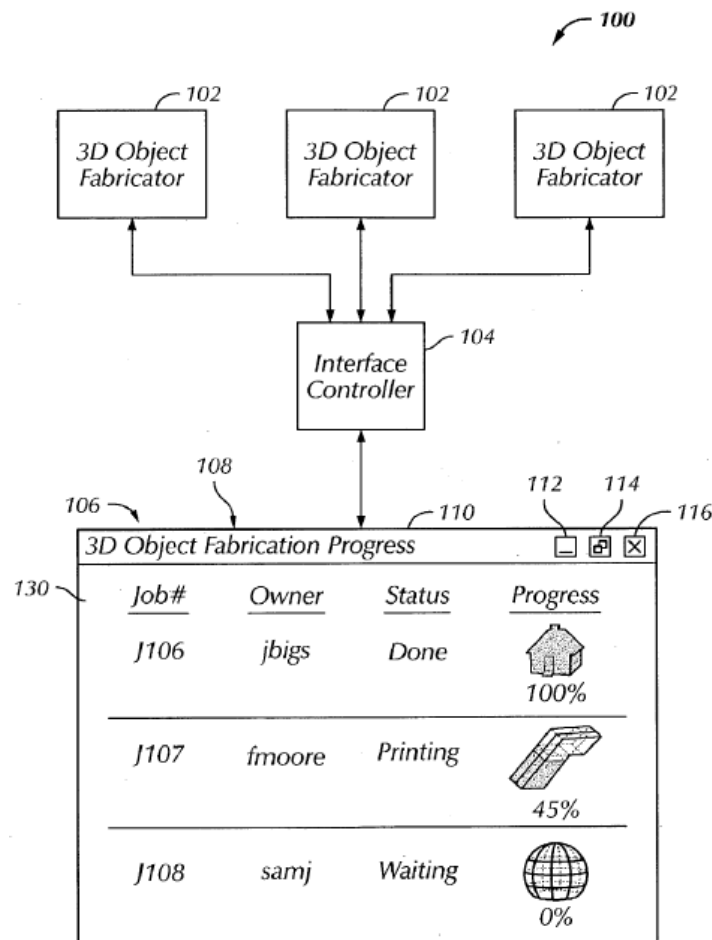


FIG. 1

EX1012, FIG. 1, [0019].

Fourth, providing an express indication of completion of the fabrication process would have allowed users to conduct post fabrication actions in a timely

manner. EX1003, ¶189. Finally, application of Anderson’s teachings to Mazumder-Mori would also be the application of known techniques to a known system ready for improvement to yield predictable results. EX1003, ¶190; *KSR*, 550 U.S. 398, 417.

3. *Application of Mazumder-Mori-Anderson to Claims 20-22*

Claim [20]

Anderson expressly discloses that the “status” of the object fabrication process is changed to “Done” upon completion of the object and the “progress” indicator shows the wireframe of the model of the object as 100% filled in. EX1012, [0019], [0021].

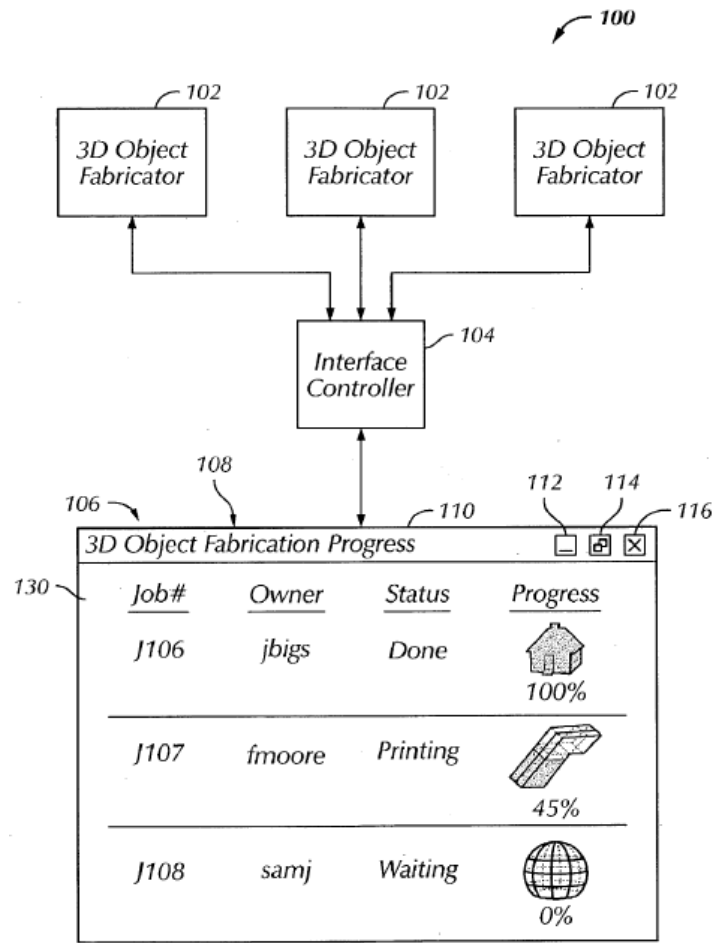


FIG. 1

EX1012, FIG. 1. A POSITA would have recognized that this change of the status to “Done” upon completion of the object satisfies claim 20. EX1003, ¶¶192, 69-72.

Claim [21]

As discussed in Ground 1A, Mazumder sends status information for display at the remote computer 95 as part of the user interface. EX1004, 6:24-55, Abstract; Element [1.d], *supra*; EX1003, ¶138. Anderson also describes that this information is displayed as part of the user interface displayed at the remote device

which can be “implemented via the printer driver” of the computing device at the fabrication site. EX1012, [0017]-[0021].

Claim [22]

See Ground 1A Analysis of Element [1.d] and Claims [6], [20]-[21].

EX1003, ¶¶139-141. According the Patent Owner’s infringement contentions, the same image that satisfies Elements [1.d] and [19.d] also satisfy this claim.

EX1016, 187-189.

H. GROUND 2A: Kritchman-Tay-Henke renders obvious claims 1, 3, 5-7, 9-10, and 19-22

1. Kritchman

Kritchman describes “a 3D printer system 100” having a “controller 105” coupled to a “printing apparatus 140.” EX1015, [0072]; EX1003, ¶¶79-83.

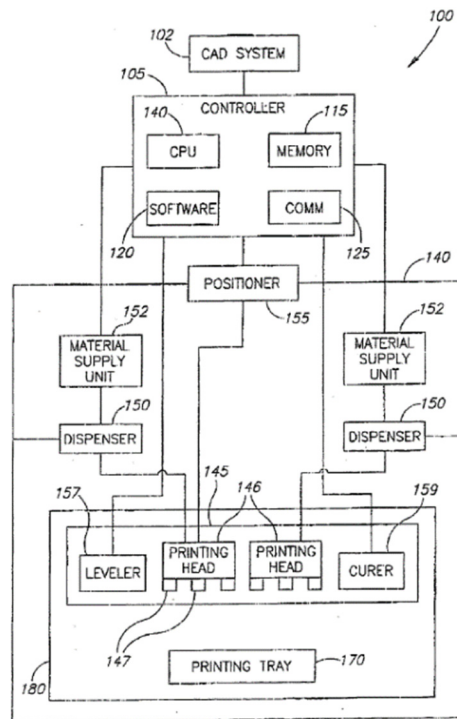


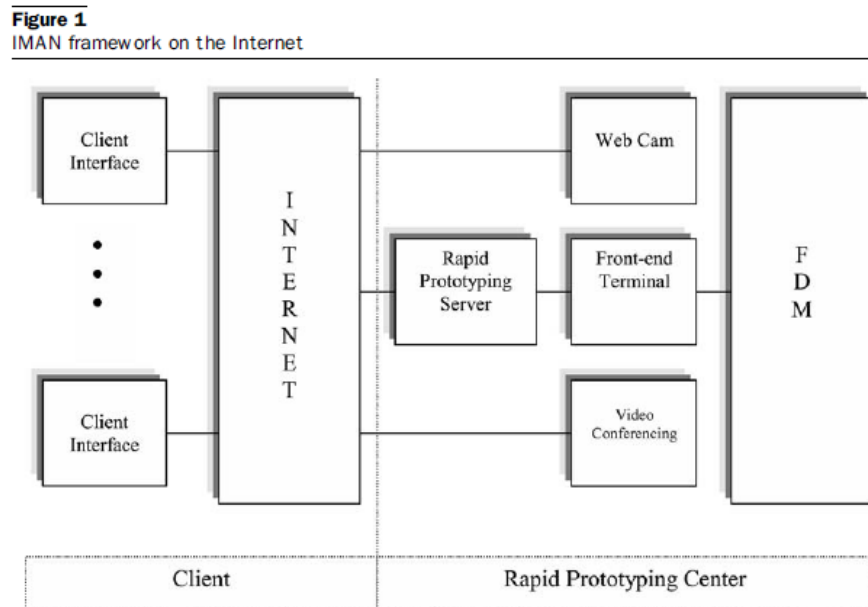
FIG.1

EX1015, FIG. 1. The controller 105 may be “located inside printing apparatus 140.” EX1015, [0073]-[0075]. The controller 105 receives “CAD data in STL format” and converts such data into 3D printing instructions “to print a 3D object.” *Id.*, [0075], [0058]-[0059] (“layer-by-layer deposition.”).

The controller 105 includes a processor and communications unit 125 to “enable transfer of data and instructions between controller 105” and “other system elements.” EX1015, [0073]. “Control functionality may be spread across units,” for example “a separate unit, such as a personal computer or workstation...may provide some control or data storage capability.” *Id.* [0073].

2. *Tay*

Tay describes “a distributed rapid prototyping system via the Internet.” EX1013, 1; EX1003, ¶¶73-77. This includes “client server communications for the remote control of rapid prototyping hardware (called fused deposition modeling) via the Internet.” *Id.* Figure 1 shows the client devices interfacing directly with the rapid prototyping center via the Internet:



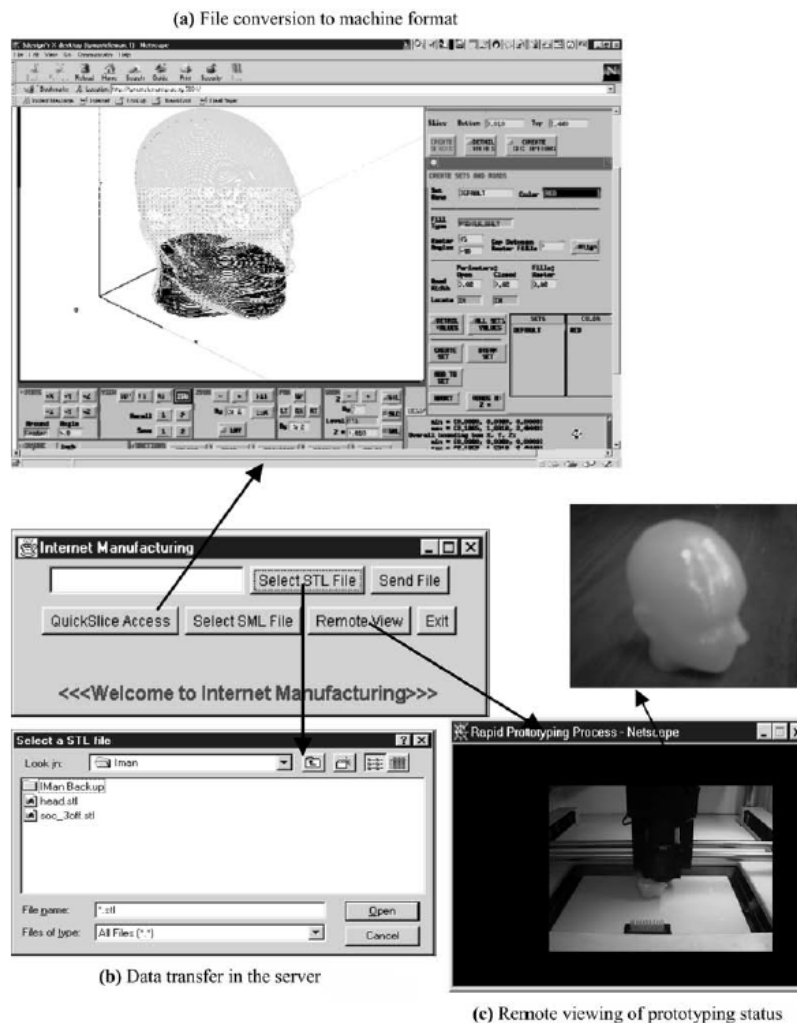
EX1013, 3.

Tay utilizes “a platform neutral framework for the construction of the human computer interface (HCI).” *Id.*, 2. The client device includes an interface “for configuring and monitoring the remote prototyping system” via a web cam that provides “audio and visual feedback.” *Id.*, 2-5. The client device “interact[s] with

the server transparently” through use of “common Web tools such as Netscape Communicator browser.” *Id.*

Tay’s user interface displays a virtual rendering of the object being fabricated in comparison to a wireframe of the entire object and actual images of the object being fabricated as captured by the Web cam. EX1013, 5.

Figure 3
(a) File conversion to machine format (b) Data transfer in the server (c) Remote viewing of prototyping status



EX1013, 5.

3. *Henke*

Henke describes use of “Rapid Prototyping modules” in “a Remote Lab system” that “enables a Web-based access to control electro-mechanical models.” EX1014, 2. Henke describes that “Remote Labs can open opportunities, allowing an experimental approach for a wider audience and an independence of opening times of the laboratory as well.” EX1014, 5. Henke’s “Web-interface” allows a remote user test control remote, real-world devices including “handl[ing] the laboratory procedure (start, stop, reset),” “change environmental variables if necessary and,” “watch the laboratory procedure by supervising the model” including “observing the hardware model directly via a Web-Cam.” *Id.* Henke’s user interface for includes camera images of the actual hardware, a model of a virtual version of the hardware, and other status and control information:

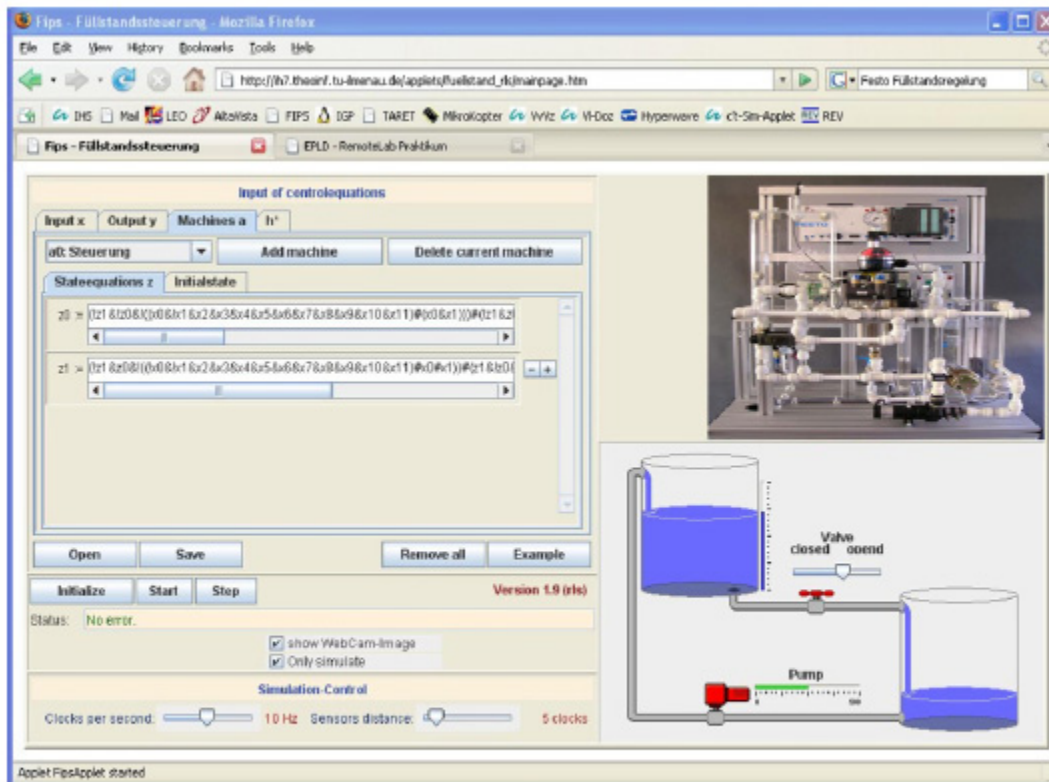


Figure 8. Online control of the Water level control - with Internet connectivity to the Remote Lab

EX1014, 5; EX1003, ¶78.

4. The Kritchman-Tay-Henke Combination

Multiple reasons would have prompted a POSITA to apply Tay's suggestions to Kritchman's 3D printer system to allow for remote control (including transfer of the CAD model) and viewing/monitoring of the 3D printing process over the Internet. EX1003, ¶¶197-209. Kritchman expressly describes spreading control functionality across multiple units, such as by using "an external control or processing unit" ("a personal computer") to "provide some or all of the printing system control capability" and describes a "communications unit 125" for

communicating with such an external computer. EX1015, [0073]-[0075]. Tay compliments this disclosure of Kritchman by describing a system to beneficially allow “a wide audience using a disparate range of computer systems to access remotely located rapid prototyping facilities” via already existing Internet infrastructure. EX1013, 1, 6. As Tay observes, rapid prototyping decreases the cycle time and cost of product development. *Id.*, 2, 6 (“...considerably reduce the product development lead time”). Thus, applying Tay’s suggestions regarding remote control and observation of 3D printing to Kritchman’s system would have predictably “enhance[d] the accessibility of available rapid prototyping services to a broader community of users.” *Id.*, 2; EX1003, ¶¶197-199. Additionally, this predictable improvement to Kritchman’s system would have “provid[ed] manufacturing facilities to geographically separated partners.” EX1003, 2; EX1003, ¶200. As such, geographically distributed teams would have advantageously worked in conjunction and utilize rapid prototyping systems (such as Kritchman’s) “without the need for their own investment for setting up costly prototyping facilities.” *Id.*

Furthermore, Tay suggests a “platform neutral framework” that “is kept simple” such that the remote user interface can be implemented in any web browser and is “very transparent and user friendly” without requiring “extra plug-ins to run the application.” EX1013, 2-4; EX1003, ¶201. Tay also provides

convenient remote monitoring of the fabrication process through one or more WebCams to allow improved remote control and provide observation for “multiple clients” in different locations. EX1013, 4; EX1003, ¶202. Implementing such remote monitoring Kritchman’s system in would have advantageously allowed remote users to visually identify defects or problems in the fabrication process, allowing users to stop defective fabrication processes and improve the design and/or process. EX1003, ¶202.

Multiple reasons would have prompted a POSITA to further apply Henke’s suggestions to the Kritchman-Tay system to (1) display both the actual video images of Tay’s fabrication process and the virtual model of the process simultaneously and from the same viewing perspective, and (2) include additional control functionality in the user interface to control the fabrication process (such as start, stop, or reset commands suggested by Henke). EX1003, ¶¶203-208.

Based on Henke’s suggested improvements, a POSITA would have recognized that simultaneously displaying actual images of the fabrication process and the visual representation of the model (and from the same perspective) on the client device beneficially allowed an onscreen comparison to quickly identify whether the fabrication process is proceeding correctly and that the object matches the model. EX1003, ¶¶203-206. Indeed, Henke’s suggested improvements would have furthered Kritchman’s goal of preventing “defects in the finished product”

because the onscreen visual comparison would have allowed the user to “adjust” the fabrication process or model to eliminate faults and “achieve a fault free solution.” EX1015, [0071], [0080]; EX1014, 5; EX1003, ¶206. The remote user would have also been able to more easily assess the progress of the fabrication process, such as in instances where the actual images of the process may be partially or completely obscured, such as by a portion of the fabrication system or a support structure. EX1003, ¶207. Displaying the virtual image of the model, the actual image of the process, and additional status and parameter information (as suggested by Henke) simultaneously also would have provided more full information to the remote user to allow the user to better monitor all aspects of the fabrication process. EX1003, ¶208.

Implementing the Kritchman-Tay-Henke system to include additional control functionality (e.g., starting, stopping, and/or resetting) and for adjusting or setting various process parameters (including the temperature control parameters of Kritchman), would have beneficially allowed the remote user to ensure: (1) that fabrication parameters are set correctly, (2) that the process is started when the remote user is ready and able to observe the process, and (3) that the process can be stopped or reset if the remote user visually identifies errors in the object or the fabrication process. EX1014, 5; EX1003, ¶¶203-205, 208. For example, implementation of start, stop, and reset controls would allow the user to abort a

defective fabrication process as soon as a defect is detected to avoid wasting time and deposition material. *Id.*

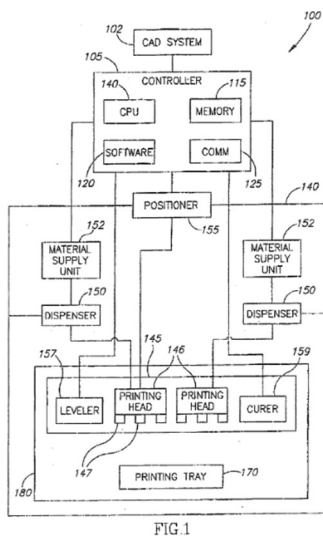
Finally, a POSITA would have been prompted to modify the rapid fabrication system of Kritchman based on Tay and Henke because doing so would be merely the application of known techniques to a known system ready for improvement to yield predictable results. EX1003, ¶208; EX1014, 5. *KSR*, 550 U.S. at 417. Both Kritchman and Tay disclose that their teachings are compatible with a wide variety of 3D printing devices. EX1015, [0058]-[0059]; EX1013, 2-3. Kritchman contemplates various “modifications” including additional “software and/or apparatuses” and Tay and Henke provide such beneficial suggested modifications. EX1015, [00156]-[00157]; EX1003, ¶208. Furthermore, Tay states that “[f]uture research works” will include designing “[a] highly interactive GUI...to communicate with the Programmable Logic Controller...to achieve more intelligent functions of the system remotely” and Henke describes desirable features to include in these future GUI developments. EX1013, 6; EX1003, ¶208. Additionally, although Tay contemplates separating its “server applications and front-end terminal applications,” a POSITA would have recognized that improvements in computing capacity between Tay’s 1999 submission date and the 2010 priority date of the ’324 patent would have rendered such a separation unnecessary and thus Kritchman’s single, integrated controller implementation

would have readily handled the additional functionality described in Tay (and Henke). EX1013, 3; EX1003, ¶208.

5. *Application to Challenged Claims 1, 3, 5-7, 9-10, and 19-22*

Element [1.pre]

Kritchman describes “a 3D printer system 100” having a “controller 105, and printing apparatus 140.” EX1015, [0072]. “Controller 105 may be located inside printing apparatus 140” and is thus a device. *Id.*, [0075], [0073]; EX1003, ¶¶210-211, 79-83.

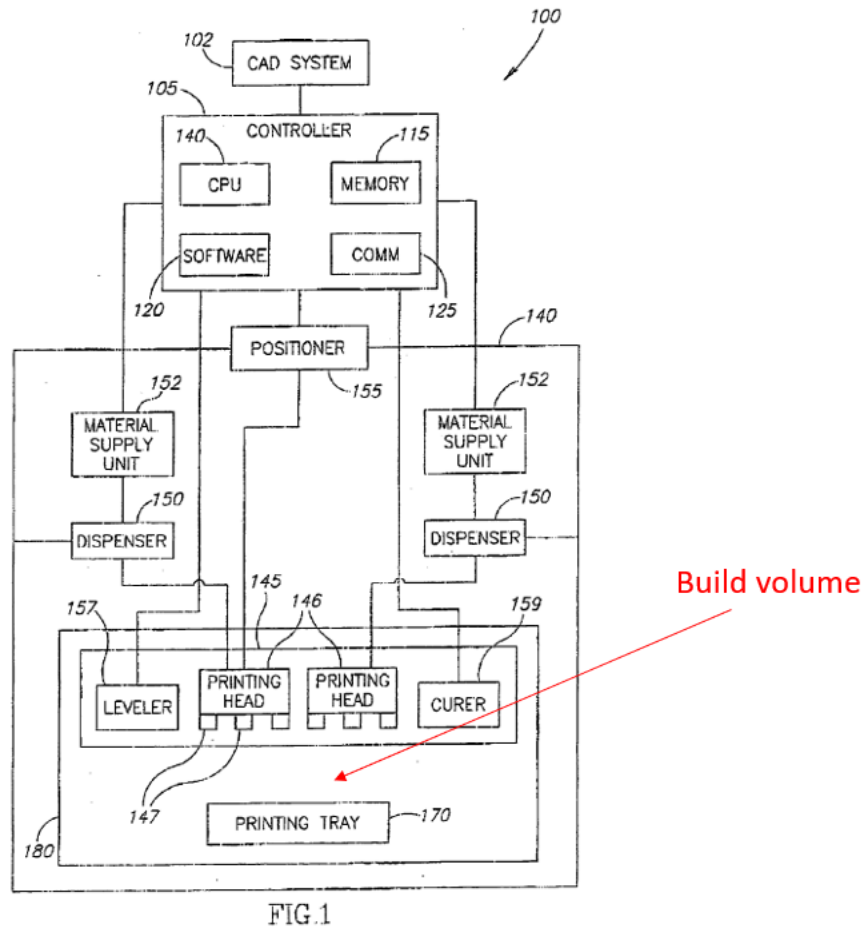


EX1015, FIG. 1.

Element [1.a]

Kritchman’s “3D printer system 100” includes “printing apparatus 140.” EX1015, [0072]-[0075]. As shown in FIG. 1, the printing tray 170 (and the work

space immediately above) is a build volume. EX1015, [0074], [0085]-[0088];
EX1003, ¶¶212-213.



EX1015, FIG. 1.

Element [1.b]

The predictable Kritchman-Tay-Henke combination provides this element.
EX1003, ¶¶214-215. First, Kritchman's controller 105 (which is integrated into the printing apparatus 140) includes "a communications unit 125" to "enable transfer of data and instructions between controller 105...and other system

elements.” EX1015, [0073]. Kritchman describes that this includes communications with “an external control or processing unit” such as a “personal computer” that “provide[s] some or all of the printing system control capability.” *Id.*, [0073]-[0075]; EX1003, ¶214.

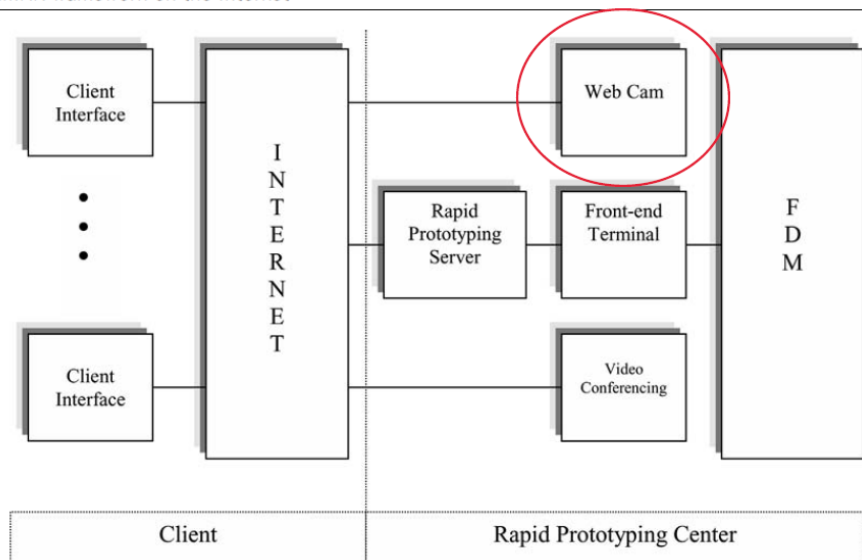
In the predictable combination (articulated above), Kritchman’s “communications unit 125” of the controller 105 would have predictably functioned as a “network interface” so as to beneficially allow “a wide audience using a disparate range of computer systems to access remotely located rapid prototyping facilities” via already existing Internet infrastructure. EX1013, 1, 6; EX1003, ¶215. Indeed, Tay plainly teaches that the data network in the predictable combination would have been “the Internet,” and thus Kritchman’s “communications unit 125” would have been implemented to receive/send internet communications with the remote computer to thereby achieve the known benefits articulated above. EX1013, 1-6.

Element [1.c]

Kritchman describes that the 3D “printer system” can include an “imager.” EX1015, [0059]. Tay elaborates that in the predictable combination “audio and visual feedback” are provided from the rapid prototyping center “by the use of Web cam and video conferencing.” EX1013, 4 (“multiple clients could be allowed to watch the same fabrication process...”); EX1003, ¶¶216-218.

Figure 1

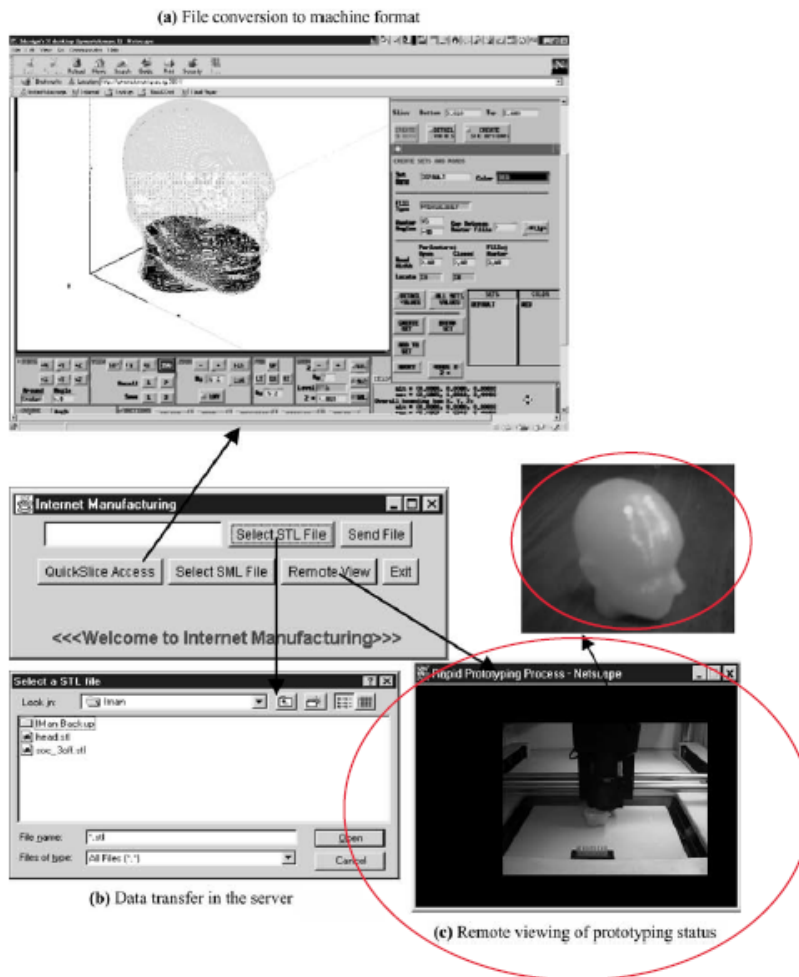
IMAN framework on the Internet



EX1013, 3.

Figure 3

(a) File conversion to machine format (b) Data transfer in the server (c) Remote viewing of prototyping status



EX1013, 5. A POSITA would have recognized that, in the Kritchman-Tay-Henke combination, the WebCam would have been integrated into Kritchman's 3D printer (like the other controller/feedback equipment) to allow for control/positioning of the WebCam and communication to/from the WebCam to be controlled by Kritchman's controller 105. EX1003, ¶217.

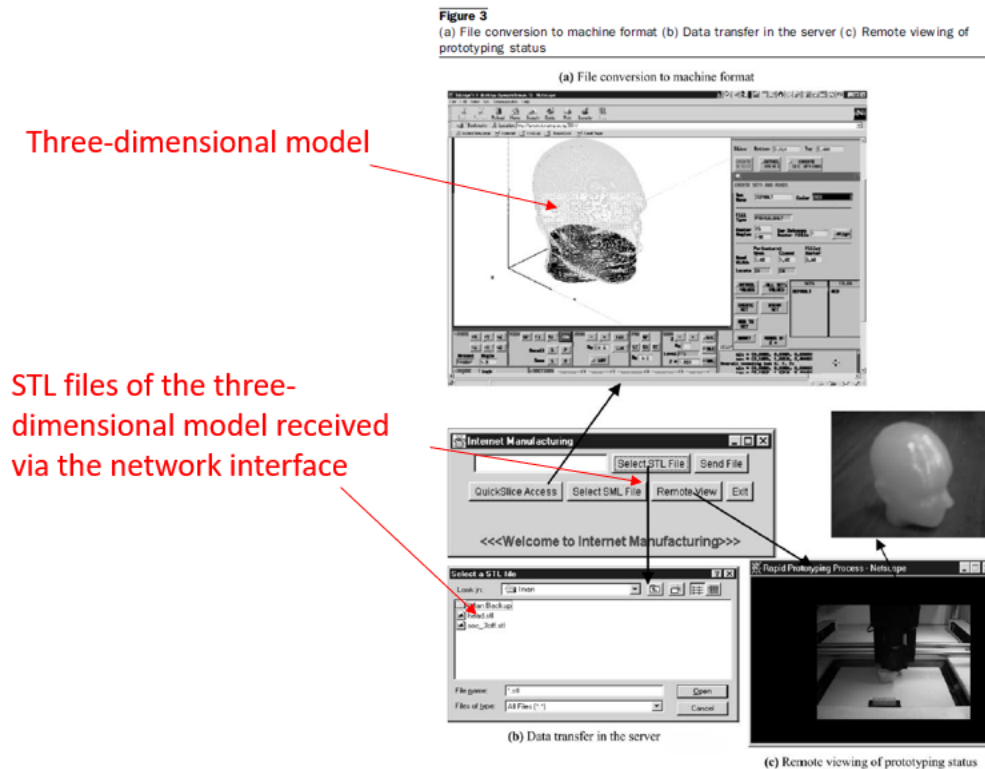
Henke similarly describes allowing the remote user to observe the automated process "directly via a Web-Cam." EX1014, 5-6; EX1003, ¶218.

Element [1.d]

Kritchman's controller 105 includes "a processor 110" such as a "CPU" for controlling the 3D printer system. EX1015, [0073], [0077]. Kritchman's controller 105 receives "Computer Object Data (COD) representing an object or *a model*, for example, *CAD data in STL format*" from an external CAD system/module 102. EX1015, [0072]-[0075], FIG. 1. Kritchman's "[c]ommunications unit 125" (i.e., the network interface) "enable[s] transfer of data and instructions between controller 105 and CAD module 102." *Id.*, [0073]. The controller 105 converts this CAD model data "to instructions for the various units within 3D printer system 100 to print a 3D object." *Id.*, [0075]. A POSITA would have recognized from Kritchman's disclosures as a whole that this fabrication of the 3D object occurs within the build volume defined by/above printing tray 170. EX1015, [0074], [0085]-[0088]; EX1003, ¶¶219-220.

In the predictable combination, Kritchman's CAD module 102 is part of the remote client device, which allows the remote user to provide the CAD model through the Internet via the network interface. EX1003, ¶221. Tay describes "reliable data transfer...and successful access to the remotely located server applications for data conversion to machine format." EX1013, 4. More expressly "converted CAD data" is transmitted over "long distance transmission" and conver[ted] to the machine format by the QuickSlice translator." *Id.* This CAD

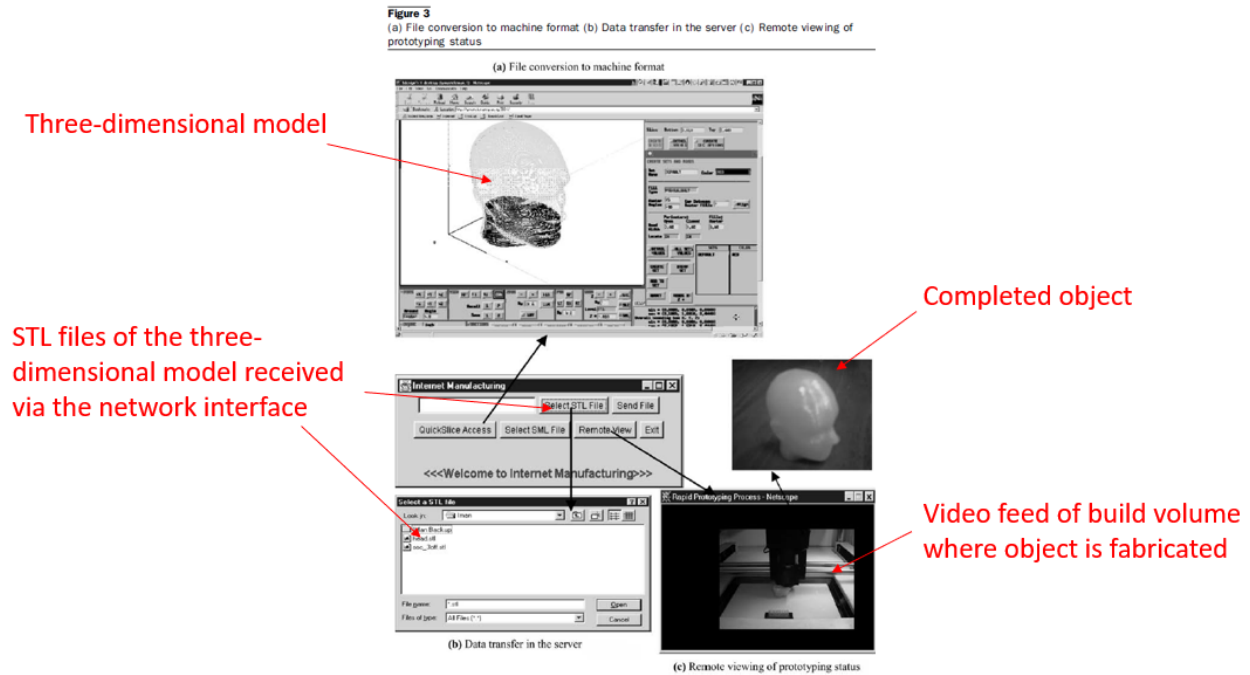
data would have been received via the communications unit 125 (network interface) in the predictable combination. EX1003, ¶221. Similar to Kritchman's teaching, Tay's "CAD data" takes the form of STL files representing a three-dimensional model of the object:



EX1013, 5; EX1003, ¶¶221-223; *see also* EX1014, 2, 4, 8.

As discussed in Section V.H.4, *supra*, Henke would have been beneficially applied to Kritchman-Tay to include additional control functionality in the user interface for controlling the fabrication process, including start, stop, and reset commands taught by Henke. EX1014, 5; EX1003, ¶222.

Tay discloses that the user interface of resulting system shows both an image of the build volume from the video camera and a two-dimensional projection of the three-dimensional model:



EX1013, 4-5.

As Tay describes, the WebCam allows for “concurrently viewing of the rapid prototyping status.” *Id.*, 4, *see also* 2-3 (discussing the WebCam), 5; EX1003, ¶¶223-224. Although Tay shows the WebCam and Video Conferencing system of its rapid prototyping center as having separate communications links from the server, it would have been obvious to a POSITA when applying Tay’s teachings to Kritchman to implement all communications to and from the 3D printer (that includes controller 105) via Kritchman’s communications unit 125.

EX1003, ¶225. Such an implementation would have eliminated the need for additional hardware (an additional communications unit and related controlling hardware). *Id.* Indeed, Kritchman describes conducting all communications “between controller 105 and other system elements” (such as Tay’s WebCam) via the communications unit 125. EX1015, [0073]. Furthermore, such an implementation using a single network interface (as taught by Kritchman) would have reduced the number of components required for the device, thereby reducing the overall footprint and improved efficiency by eliminating the need for communication between disparate components within the resulting system.

EX1003, ¶225.

As shown in Tay’s Figure 3 (reproduced above), the view of the completed object and the displayed two-dimensional projection of the three-dimensional model appear to be from the same point of view. EX1003, ¶226. To the extent that Patent Owner contends narrowly that the image from the WebCam and the image of the three-dimensional model in Tay are not shown from the same point of view and/or that this claim requires displaying the model and the image of the build volume simultaneously, Henke would have been beneficially applied to Tay to provide such features, as discussed in Section V.H.4, *supra*. EX1003, ¶227. Specifically, Henke discloses a user interface in which the video image of the actual automated process and the model of the process are shown concurrently and

from the same point of view to allow the user of the resulting combination to easily compare the actual process to the model:

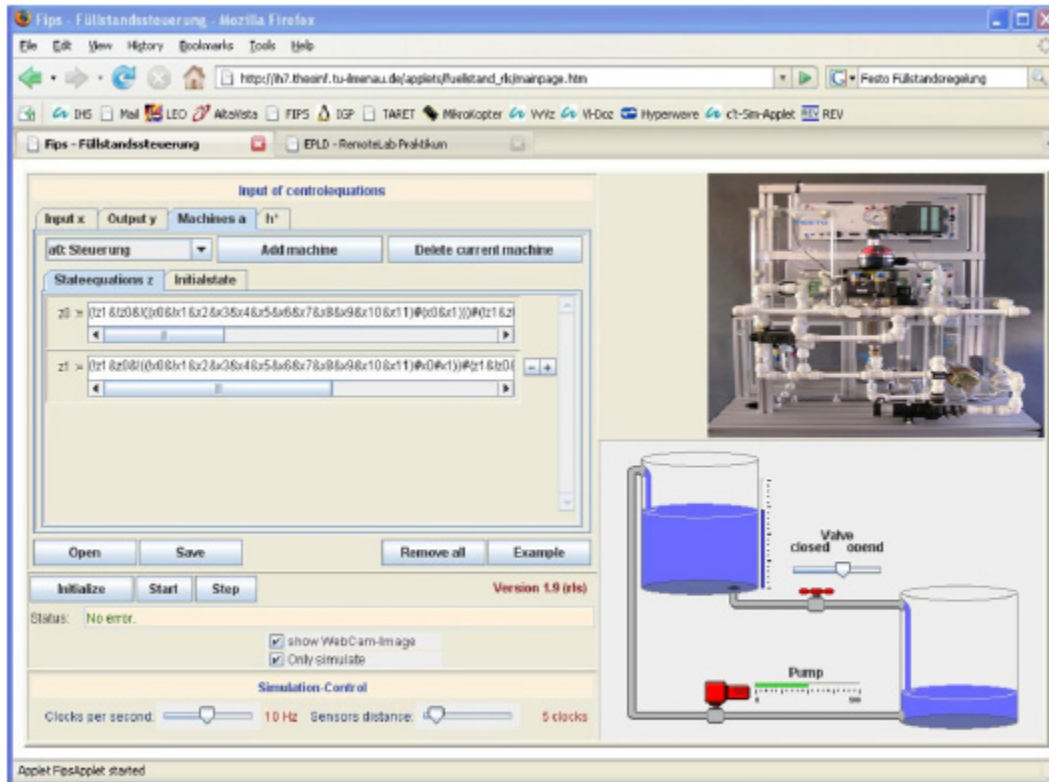


Figure 8. Online control of the Water level control - with Internet connectivity to the Remote Lab

EX1014, 5; EX1003, ¶227.

Kritchman's communications unit 125 communicates with "an external control or processing unit" such as a "personal computer," which in the predictable combination includes the remote client interface computers described by Tay.

EX1015, [0073]-[0075]; EX1013, 2-3; EX1003, ¶228. Tay discloses that the user of the remote client computer in the predictable combination accesses the user interface using a generic web browser. EX1013, Figure 3 (reproduced above

showing the user interface in a browser), *see also* EX1014 Figure 8 (reproduced above showing the user interface accessed in a browser). Tay describes “a ***platform neutral*** framework for the construction of the human computer interface (HCI).” EX1013, 2. Specifically, “the user does not need to download and install extra plug-ins to run the application” but only needs “common Web tools” such as “Netscape Communicator browser.” *Id.*, 3. Because the user interface is presented in a generic web browser with no “extra-plug-ins” or specialized software via direct communication with Kritchman’s controller 105 (modified to include functionality of Tay’s rapid prototyping center), a POSITA would have understood that the user interface is generated and provided by the controller 105 in the predictable combination. EX1003, ¶228; *see also* EX1015, [0073]-[0075], FIG. 1; EX1013, Figure 1.

Claim [3]

Henke discloses that in the Kritchman-Tay-Henke combination the two-dimensional projection is simulated based upon operation of the three-dimensional printer. EX1003, ¶¶229-232. Specifically, Henke shows that the model of the automated process is shown along with the video feed of the actual process so that the user can “watch the laboratory procedure by supervising the model and environmental variables inside an I/O monitor or by observing the hardware model directly via a Web-Cam.” EX1014, 5.

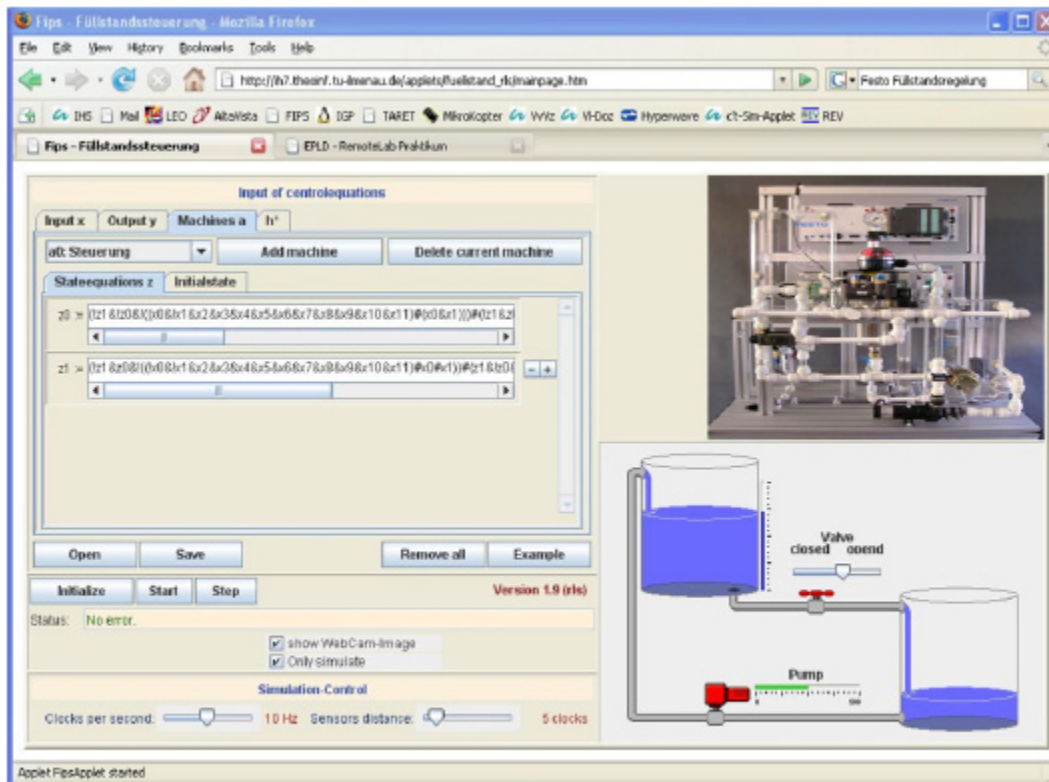


Figure 8. Online control of the Water level control - with Internet connectivity to the Remote Lab

As such, a POSITA would have recognized that in the predictable combination, the model is updated as the deposition process proceeds to allow the user to beneficially compare the progress of the actual object with respect to the model to achieve the benefits discussed in Section V.H.4, *supra*. EX1003, ¶¶230-231.

Alternatively, Patent Owner contends in the district court litigation that this claim encompasses merely displaying video camera images of the product at a remote computer (EX1016, 57-66), in which case Tay's disclosure of displaying

the image data of the product at the remote computer also provides this claim.

EX1013, 4-5; EX1003, ¶232.

Claim [5]

The Kritchman-Tay-Henke combination provides this claim for the reasons discussed with respect to claim 3, *supra*; EX1003, ¶¶233-234. Alternatively, Patent Owner contends in the district court litigation that this claim encompasses merely displaying video camera images of the product as it is fabricated at a remote computer (EX1016, 67-90), in which case Tay's disclosure of displaying the image data of the product at the remote computer also provides this claim.

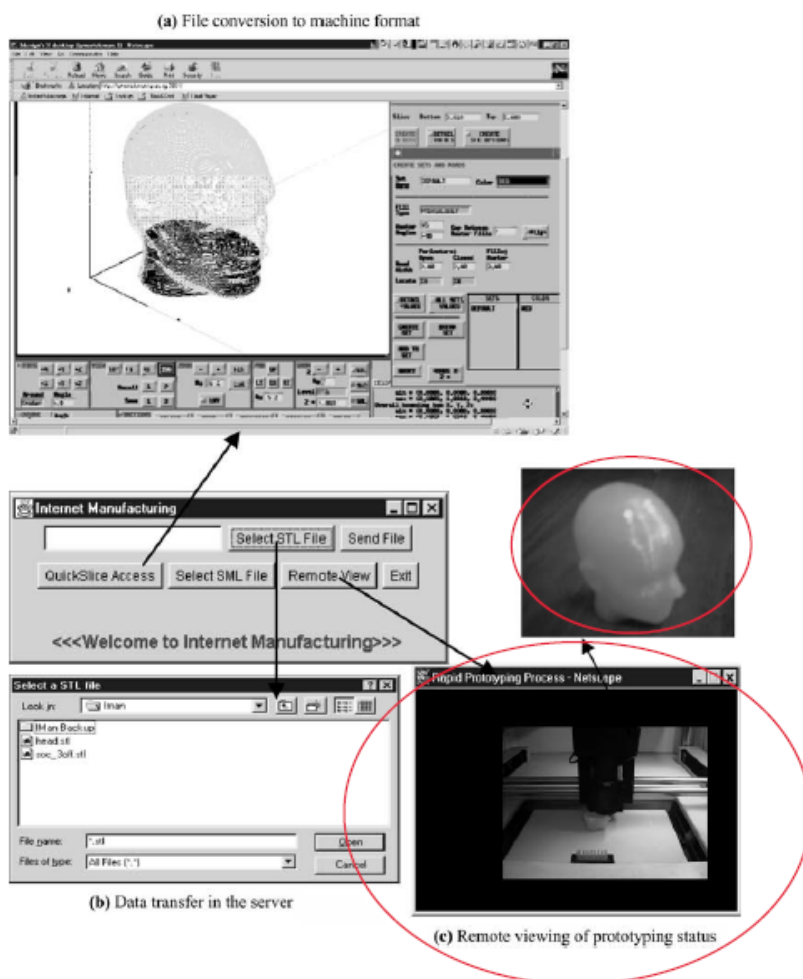
EX1013, 4-5; EX1003, ¶235.

Claim [6]

Both Tay and Hanke describe displaying a video image from the video camera of the object as it is fabricated. EX1013, 4-5; EX1014, 5; EX1003, ¶¶236-237.

Figure 3

(a) File conversion to machine format (b) Data transfer in the server (c) Remote viewing of prototyping status



EX1013, 5.

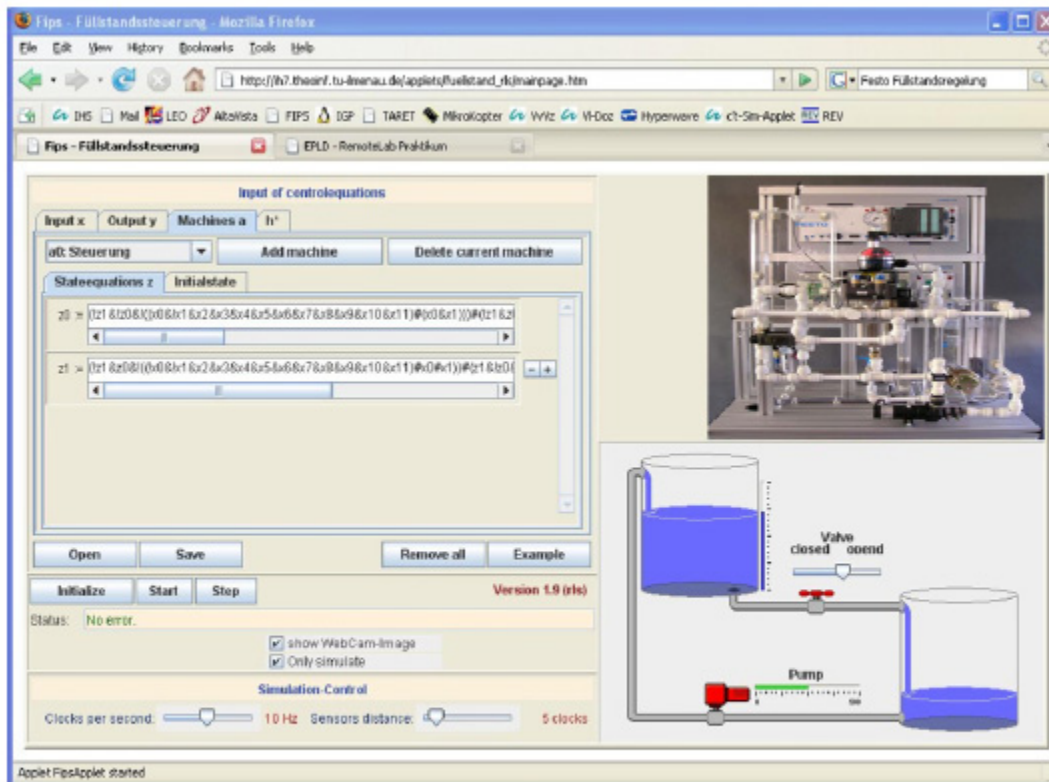


Figure 8. Online control of the Water level control - with Internet connectivity to the Remote Lab

EX1014, 5.

Patent Owner's infringement contentions indicate that this claim element encompasses merely displaying a regular image from the video camera. EX1016, 91-105.

Claim [7]

As discussed in Section V.H.4, *supra*, Henke would have been predictably applied to Kritchman-Tay to include additional control functionality in the user interface to control the fabrication process (including start, stop, and reset commands taught by Henke). EX1003, ¶238. Henke's "Web-interface" allows a

remote user test control algorithms in remote, real-world devices including “handl[ing] the laboratory procedure (start, stop, reset),” and “change environmental variables if necessary.” EX1014, 5.

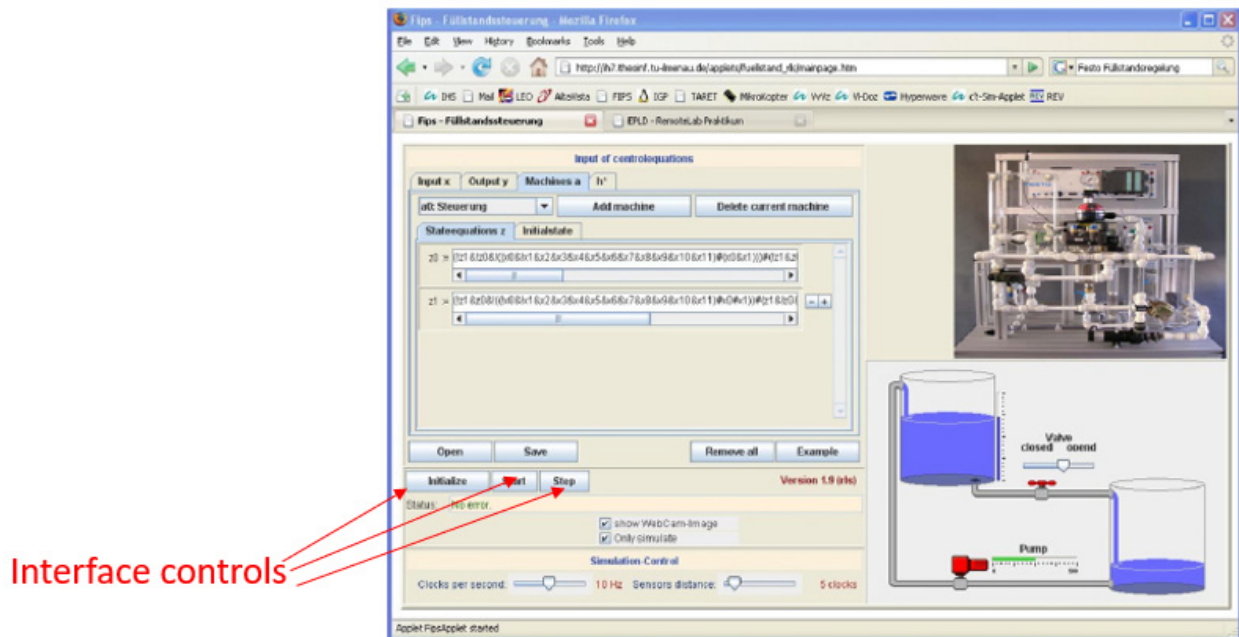


Figure 8. Online control of the Water level control - with Internet connectivity to the Remote Lab

EX1014, 5.

Claim [9]

Tay discloses that WebCam and video conferencing functionality allow the remote “viewing of the rapid prototyping *status*.” EX1013, 4-5. Henke similarly discloses that in the resulting combination, the user interface displays various “environmental variables.” EX1014, 5; EX1003, ¶239.

Claim [10]

The Kritchman-Tay-Henke combination provides this claim for the reasons discussed with respect to claim 9, *supra*; EX1003, ¶¶239-240.

Element [19.pre]

The Kritchman-Tay-Henke combination is directed to “methods for controlling the quality of printing in three-dimensional object-printing systems” including “remote control” and observation “of rapid prototyping hardware...via the Internet.” EX1015, [0005], [0064], [0071]; EX1013, 1-6; EX1003, ¶241.

Element [19.a]

Kritchman’s “3D printer system 100” includes a controller 105 “located inside printing apparatus 140” having a printing tray 170 that defines a build volume and a network interface in the form of communications unit 125. *See* Analysis of Elements [1.a]-[1.b]; EX1015, [0072]-[0075], FIG. 1; EX1003, ¶¶242-245, 212-218.

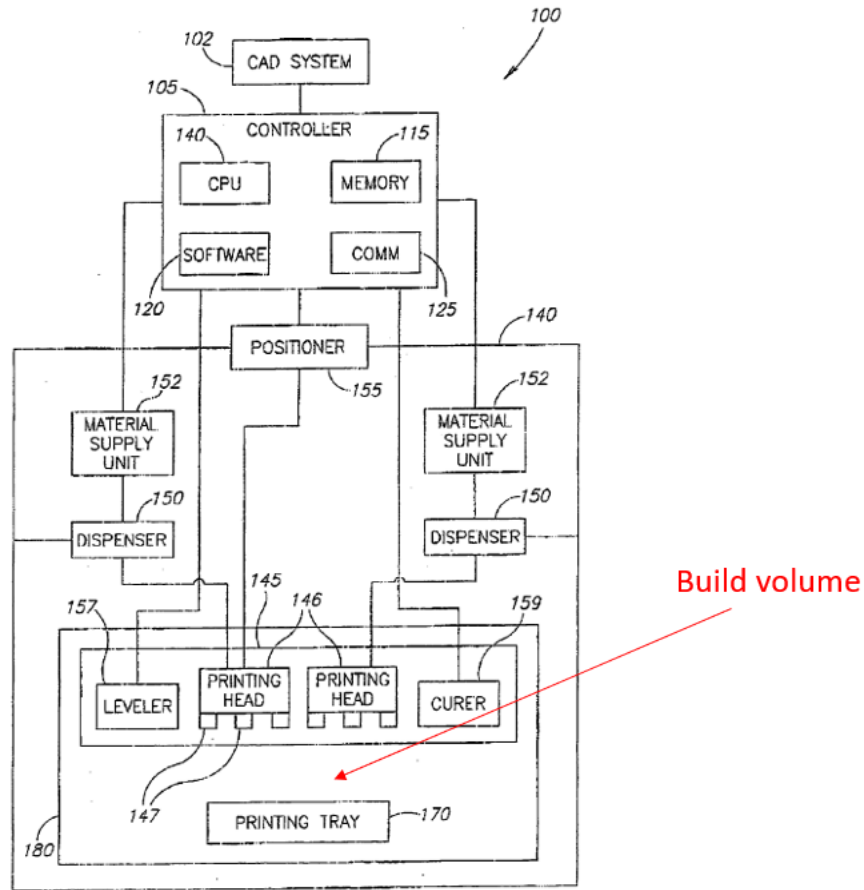


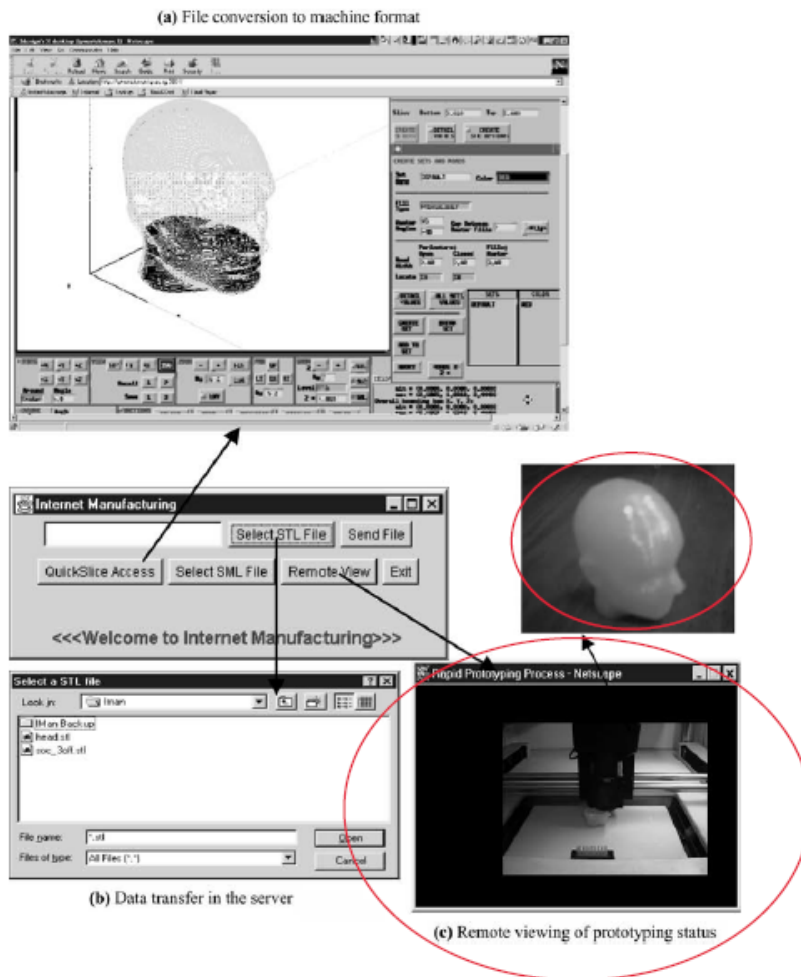
FIG. 1

EX1015, FIG. 1.

Tay discloses that in the predictable combination, the network interface is coupled to the Internet and that the 3D printer includes a WebCam that allows remote users “to watch the...fabrication process.” See Analysis of Elements [1.b]-[1.c], *supra*; EX1013, 1-5; EX1003, ¶¶245, 214-218.

Figure 3

(a) File conversion to machine format (b) Data transfer in the server (c) Remote viewing of prototyping status



EX1013, 5.

Element [19.b]

See Analysis of Element [1.d], *supra*. EX1003, ¶¶246, 219-222.

Element [19.c]

See Analysis of Element [1.d], *supra*. EX1003, ¶¶247, 219-220.

Element [19.d]

See Analysis of Element [1.d], *supra*. EX1003, ¶¶248, 222-228.

Claim [20]

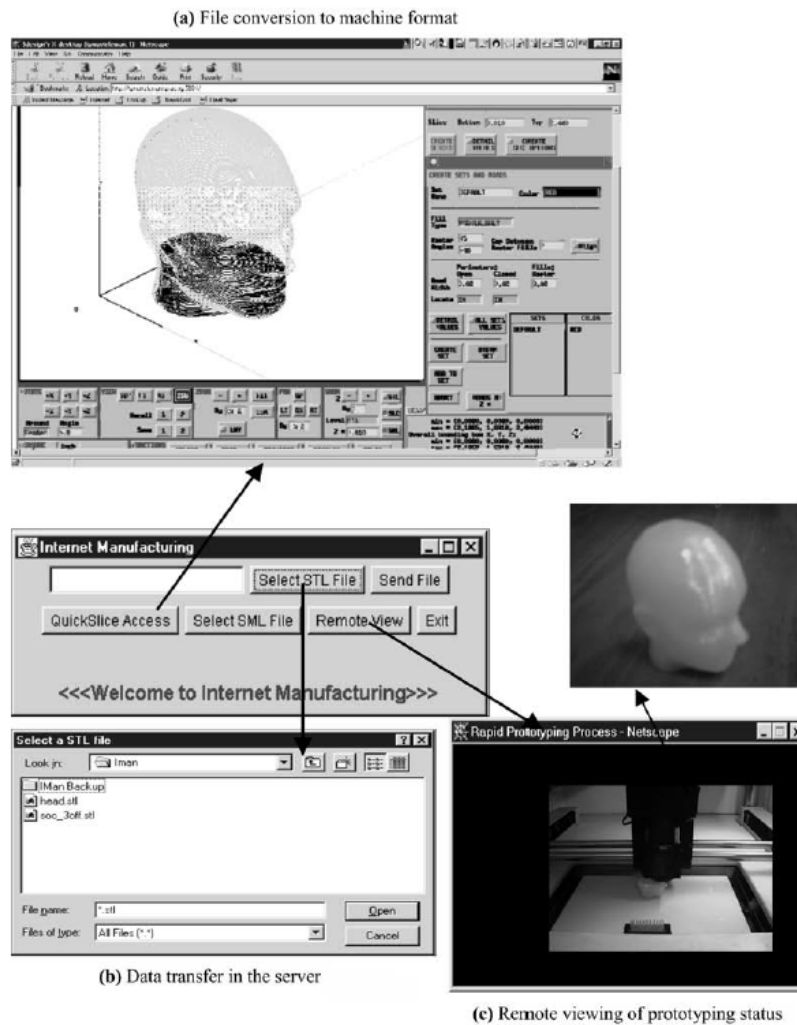
Tay describes allowing the remote user to view the fabrication process in the user interface via the WebCam. EX1013, 4-5 (“viewing of the rapid prototyping status”). Because this status information is continuously sent to the remote computer over the data network (e.g., the Internet) for display in the user interface, a POSITA would have recognized that this information is transmitted both during the fabrication process and upon completion of the product. EX1003, ¶250.

Claim [21]

Tay discloses that the images of the fabrication process are displayed in the user interface. EX1003, ¶251.

Figure 3

(a) File conversion to machine format (b) Data transfer in the server (c) Remote viewing of prototyping status



EX1013, 5; *see also* EX1014, 5.

Claim [22]

See Analysis of Element [1.d] and Claims [6], [20]-[21]. EX1003, ¶252-253.

According the Patent Owner's infringement contentions, the same image that satisfies Elements [1.d] and [19.d] also satisfy this claim. EX1016, 187-189.

I. GROUND 2B: Kritchman-Tay-Henke-Tian renders obvious claim 4

Claim [4]

A POSITA would have applied Tian to the Kritchman-Tay-Henke system to compare “the actual image data obtained by the first CCD camera 13 and the virtual image data generated to correspond to the first CCD camera 13...to determine whether these image data match.” EX1006, [0100]-[0102]. The virtual images are derived from a model. EX1006, Abstract, [0012]. If the images of the actual object and the model do not match, the system can “update[e] the model data” in response. *Id.*, [0026]-[0029], [0102]-[0103]; EX1003, ¶¶254-259, 58-60.

A POSITA would have been prompted to apply Tian’s teaching to the Kritchman-Tay-Henke system for the reasons discussed with respect to Ground 1B, *supra*. EX1003, ¶¶254-257. Such an implementation would have improved the ability of the system to detect and correct for defects while reducing the cognitive load on the human designer and allowing detection of defects that would be difficult to identify with the human eye. EX1003, ¶¶254-255; EX1015, [0071] (Kritchman discussing the importance of reducing “defects in the finished product”), [0080]; Such a modification would also be the application of known techniques to a known system ready for improvement to yield predictable results. EX1003, ¶256; *KSR*, 550 U.S. 398, 417.

J. GROUND 2C: Kritchman-Tay-Henke-Hull renders obvious claim 8

Claim [8]

A POSITA would have applied Hull to Kritchman-Tay-Henke to require a “Remote user” to “type your password and press enter” to remotely access the 3D printer. EX1008, [0157]; EX1003, ¶¶260-266. As discussed with respect to Element [1.d], *supra*, the user interface is generated and provided by the controller 105 in the Kritchman-Tay-Henke-Hull combination and therefore requiring credential-based access to the 3D printer includes requiring the credential-based access to access the user interface provided by the 3D printer. EX1015, [0072]-[0075]; EX1013, 2-3; EX1003, ¶266.

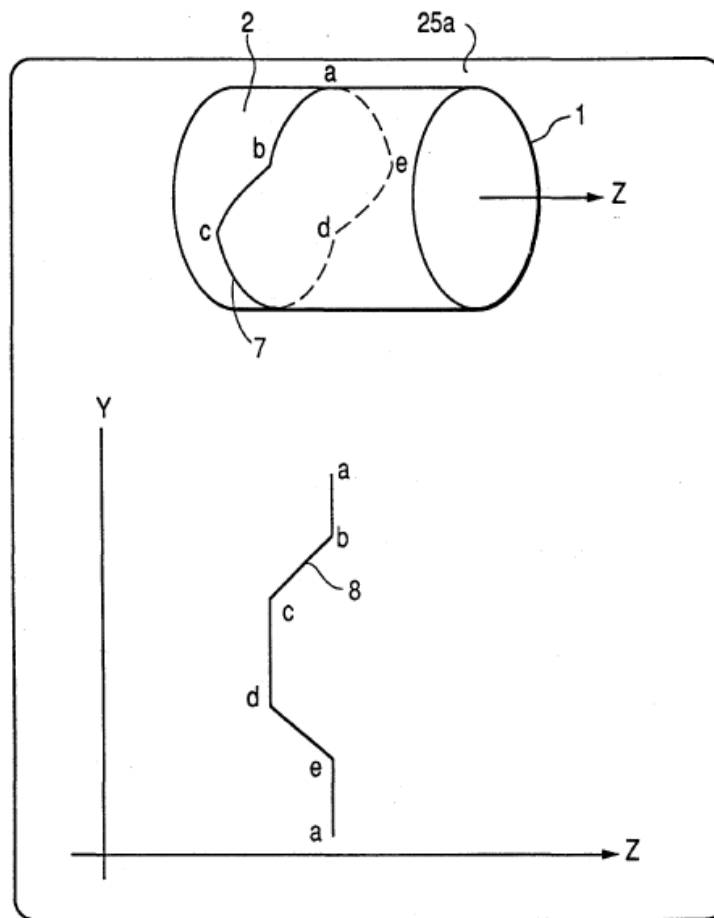
A POSITA would have applied Hull’s teaching to the Kritchman-Tay-Henke combination for the reasons discussed with respect to Ground 1C, *supra*. EX1003, ¶¶260-265. Such an implementation would have prevented unauthorized users (including bad faith users) from accessing the fabrication system, prevented unauthorized waste of fabrication time, power usage, and deposition material, prevented potential damage to the system due to unauthorized use, and allowed tracking of remote users. EX1003, ¶¶260-263.

K. GROUND 2D: Kritchman-Tay-Henke-Seki renders obvious claim 11

Claim [11]

A POSITA would have applied Seki to the Kritchman-Tay-Henke system to display a two-dimensional tool path in the user interface as the machining tool executes “motion definition statement” to move the machine tool. EX1009, 2:28-43; EX1003, ¶¶267-274.

FIG. 1



EX1009, FIG. 1; *see also* 4:19-41 (“the tool path section b'-c' is drawn on the YZ coordinate system.”) EX1009, 4:19-41; EX1003, ¶¶272-274, 63. The tool path segment is displayed to correspond to the real-time movement of the tool indicating that the displayed tool path is for the current layer. EX1003, ¶274.

A POSITA would have applied Seki’s teaching to the Kritchman-Tay-Henke combination for the reasons discussed with respect to Ground 1D, *supra*. EX1003, ¶¶267-271. Implementing Kritchman-Tay-Henke to display the tool path in the user interface would have provided additional information to the remote designer to allow the designer to understand and track the progress of the fabrication process, provided additional information for visually detecting defects in the design, and easy comparison of expected movements of the device with the actual movements to confirm correct movements. *Id.*; EX1009, 1:36-40, 4:42-50, 1:58-2:2.

L. GROUND 2E: Tay in view of Henke and Waehner render obvious claim 17

Claim [17]

Waehner describes modes for standard video and “time lapse recording video” in which “only one out of every predetermined number of sequential images or frames” is retained. EX1010, [0010], [0019]. The “predetermined rate” can be “selected by a user.” *Id.* A POSITA would have recognized that this

description of Waehner's time lapse video mode is "stop-motion" animation.

EX1003, ¶¶275-282.

Waehner describes that a "user input 43...connected to processor 36" such as "control buttons" implemented on the controlling computer is used to select the video mode (standard or time lapse) and set other parameters. EX1010, [0018]; EX1003, ¶282. As such, a POSITA would have recognized that in the Kritchman-Tay-Henke-Waehner combination, the user interface provided by the controller 105 for display at the client computer would have included at least one control for capture of the time lapse video (stop-motion animation) of the fabrication process. EX1003, ¶¶281-282.

A POSITA would have applied Waehner's teaching to the Kritchman-Tay-Henke combination for the reasons discussed with respect to Ground 1E, *supra*. EX1003, ¶¶275-280. Such an implementation would have reduced the amount of storage required for the video images captured by the camera(s) of the system. EX1010, [0004], [0019]; EX1003, ¶275. Providing a time-lapse option for the system's video data would have facilitated long term storage of large amounts of video data without the need to add additional storage capacity to allow for later review to identify "events that have not been detected and would otherwise be lost" such as defects in the object. EX1010, [0004], [0010], [0019]-[0020]; EX1003, ¶¶276-277. Such an implementation would also allow for "review[ing] of recent

events” with “the maximum amount of information” in the video while providing the storage benefits discussed above. EX1010, [0009]; EX1003, ¶278.

M. GROUND 2F: Kritchman-Tay-Henke-Lan renders obvious claim 18

Claim [18]

A POSITA would have applied Lan’s teaching to the Kritchman-Tay-Henke combination to include a remote print server in communication with the controller 105 of Kritchman’s 3D printer such that the remote user transmits the CAD model (an STL file) “via the Internet to the RP Web server” which then schedules the print job and “transmit[s] the STL file to the RP machine that [is] chosen by the customers.” EX1011, 3, 10 (describing the remote print server selecting an appropriate rapid fabrication device and scheduling the print job); EX1003, ¶¶283-293. The user provides the STL file to the web server, which queues the print job for the appropriate fabrication machine. *Id.*, 10.

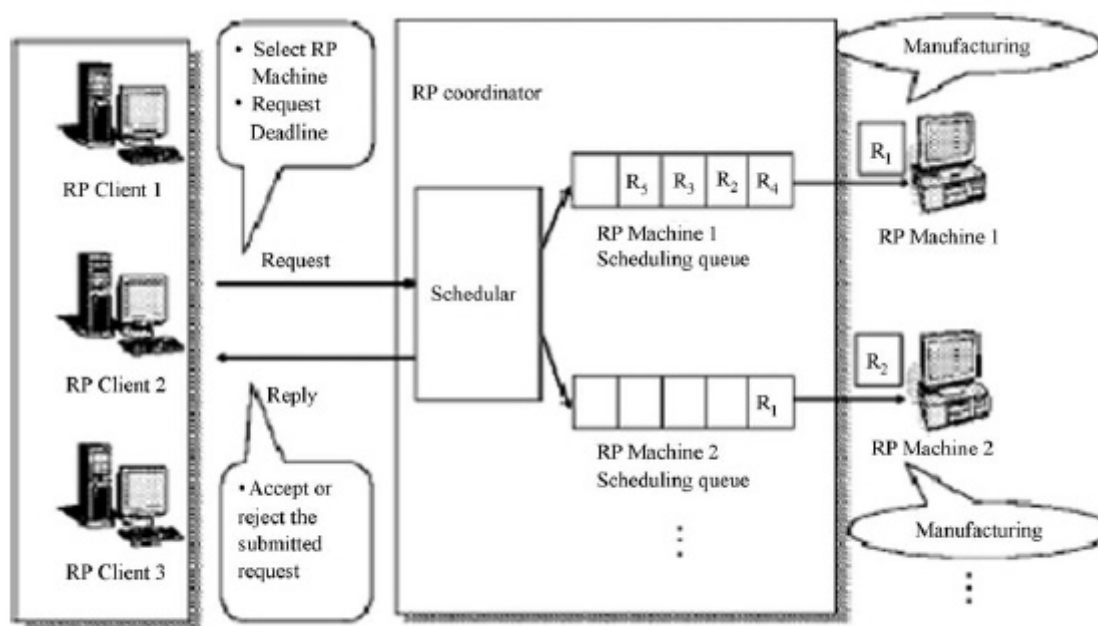


Fig. 10. Distributed RP platform scheduler [65].

EX1011, 10.

Lan's print servers coordinate print jobs between multiple users and multiple fabrication devices:

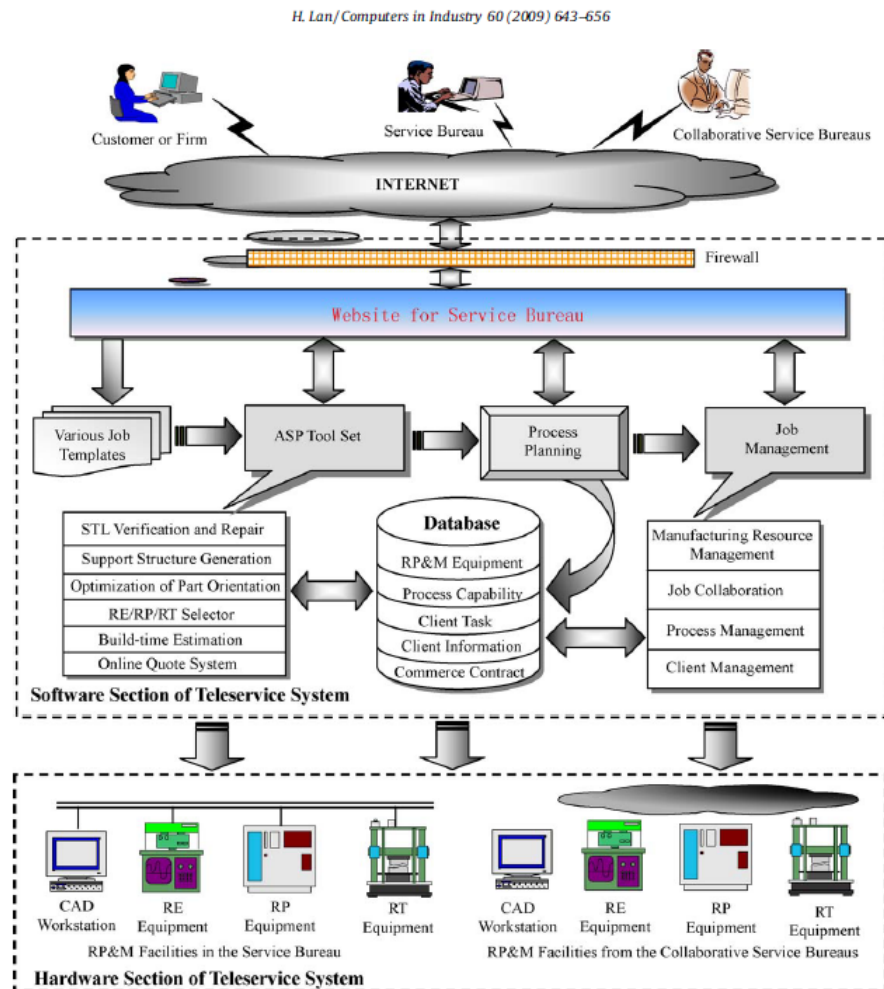


Fig. 4. Architecture of the Web-based RP&M system.

EX1011, 5.

Lan's web servers meet the description of a print server in the '324 patent.

EX1003, ¶293; EX1001, 9:4-37.

A POSITA would have applied Lan's teaching to the Kritchman-Tay-Henke combination for the reasons discussed with respect to Ground 1F, *supra*. EX1003, ¶¶283-290. Such an implementation would have allowed for multiple remote users to interface with multiple rapid fabrication devices efficiently and effectively,

would “minimiz[e] idle time” and lower “the effective cost rate” of rapid fabrication devices, allow optimal dynamic scheduling of rapid fabrication devices, and allow users to access a variety of devices, and identify site capability, using a common interface. *Id.*; EX1011, 6-10, 3.

N. GROUND 2G: Kritchman-Tay-Henke-Anderson render obvious claims 3, 5, 9-10, 20-22

1. The Kritchman-Tay-Henke-Anderson Combination

A POSITA would have been prompted to apply Anderson’s teaching to the Kritchman-Tay-Henke combination to display additional status information for the reasons discussed with respect to Ground 1G, *supra*. EX1003, ¶¶294-301. The additional context of displaying a portion of the object model completed with respect to the wireframe and other status information would have (1) increased the user’s knowledge and understanding of the overall fabrication process, (2) helped the user to readily assess the progress of the fabrication process and estimate the amount of time remaining, (3) allowed users to easily identify where in a print queue the user’s particular design is to help the user to better schedule other tasks, (4) facilitated conducting post fabrication actions in a timely manner, and (5) be the application of known techniques to a known system ready for improvement to yield predictable results. *Id.*; EX1012, FIGs. 1-2A, [0018]-[0020]; KSR, 550 U.S. 398, 417.

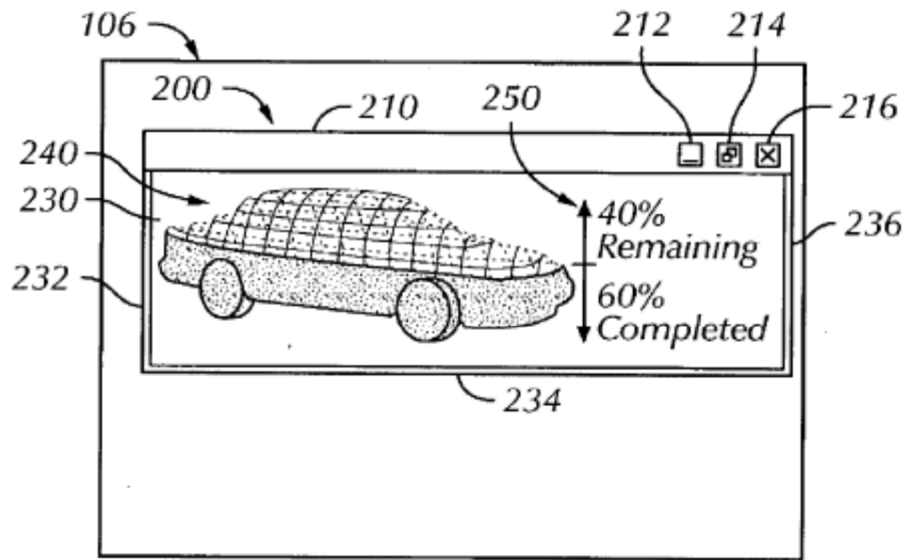


FIG. 2A

2. *Application of Kritchman-Tay-Henke-Anderson to Claims 3, 5, 9-10, 20-22*

Claim [3]

As taught by Anderson, the system tracks “progress information” including “the number of passes completed by the printhead” and based on this information updates the displayed model “to show the completed portion as a filled-in (e.g., solid colored) area.” EX1012, [0018].

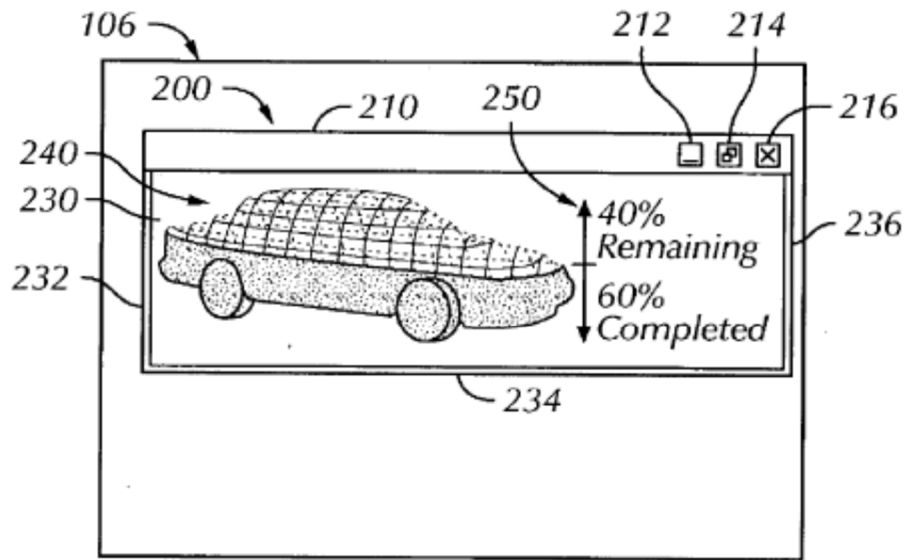


FIG. 2A

EX1012, FIG. 2A, [0018]-[0020]. Anderson also discloses that “status includes...data pertaining to three-dimensional object(s) fabrication progress.” *Id.*, [0026]; EX1003, ¶302.

Claim [5]

See Analysis of Claim [3], *supra*. EX1003, ¶¶302-303.

Claim [9]

Anderson discloses that the user interface includes status information for the three-dimensional printer, including which object is currently being fabricated by the printer, status of the print job, and progress of an in-process print job. EX1012, [0018]-[0020]; EX1003, ¶304.

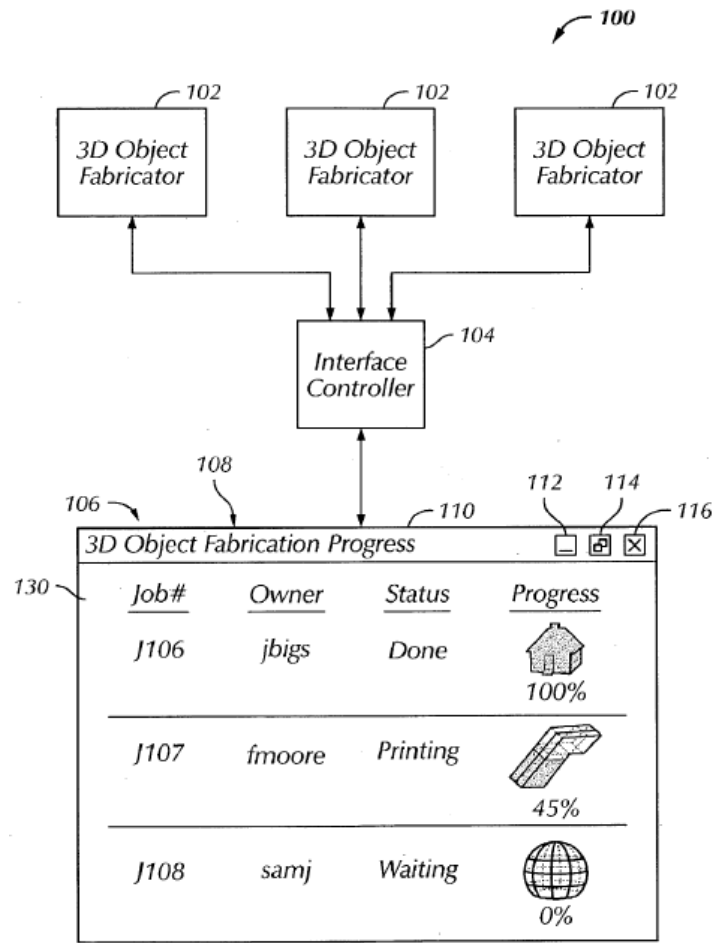


FIG. 1

EX1012, FIG. 1.

Claim [10]

Anderson discloses that the user interface includes status information for the build process, including status of the build process and percent completion of the build process. EX1012, [0018]-[0020], [0026], FIGs. 1, 2A; EX1003, ¶305.

Claim [20]

Anderson discloses that the “status” of the object fabrication process is changed to “Done” upon completion of the object and the “progress” indicator

shows the wireframe of the model of the object as 100% filled in and therefore satisfies this claim. EX1012, [0019], [0021]; EX1003, ¶306.

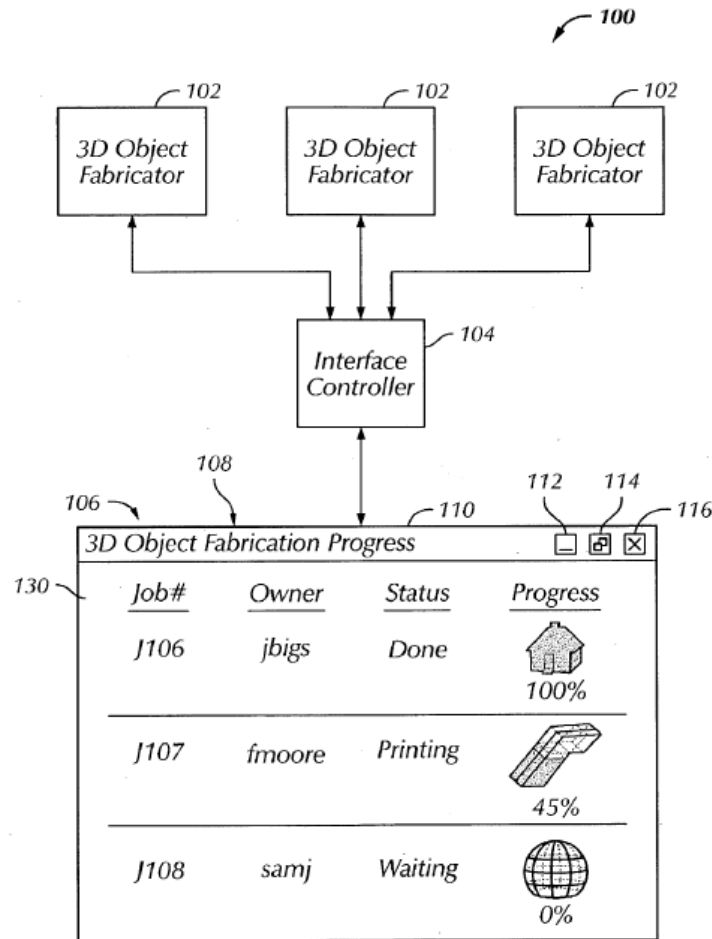


FIG. 1

EX1012, FIG. 1. A POSITA would have recognized that this change of the status to “Done” upon completion of the object satisfies claim 20.

Claim [21]

Anderson describes that the status information is displayed as part of the user interface displayed at the remote client device (in the resulting combination)

which can be “implemented via the printer driver” of the computing device at the fabrication site. EX1012, [0017]-[0021]; EX1003, ¶¶307-308.

Claim [22]

See Ground 2A Analysis of Element [1.d] and Claims [6], [20]-[21].

EX1003, ¶¶309-310. According the Patent Owner’s infringement contentions, the same image that satisfies Elements [1.d] and [19.d] also satisfy this claim.

EX1016, 187-189.

VI. DISCRETIONARY DENIAL IS NOT JUSTIFIED

A. 35 U.S.C. §314(a)—*Fintiv*

The *Fintiv* precedent should not be followed here because it exceeds the Director’s authority, is arbitrary and capricious, and was adopted without notice-and-comment rulemaking. Even if considered, the factors favor institution.

The Petition is being filed before an answer has been filed in the parallel District Court action and concurrently with a Motion to Dismiss. ***Factor 1*** is neutral since there is no evidence that, if the action is maintained and a stay is requested, the court will deny a stay. ***Factor 2*** is neutral because any final written decision in this proceeding will issue in mid-June 2026 or earlier, nearly contemporaneous with the theoretical start of jury selection on June 1, 2026 in the District Court. EX1019. ***Factor 3*** favors institution because there has been little investment by the court and the Markman hearing is scheduled for December 3, 2025, well after institution.

EX1019. **Factor 4** favors institution as Petitioner has made a stipulation not to pursue the IPR grounds in District Court. EX1018. Petitioner's Motion to Dismiss further favors institution under **Factor 6** because, if granted, there will be no potential overlap of issues between the IPR and parallel District Court action.

VII. PAYMENT OF FEES – 37 C.F.R. § 42.103

Petitioner authorizes the Patent and Trademark Office to charge Deposit Account No. 06-1050.

VIII. MANDATORY NOTICES UNDER 37 C.F.R §42.8(a)(1)

A. Real Party-In-Interest Under 37 C.F.R. §42.8(b)(1)

In addition to Petitioner, Bambulab Limited, Shanghai Lunkuo Technology Co. Ltd., Tuo Zhu Technology Limited, and Bambulab USA Inc. are listed as potential real parties-in-interest.

B. Related Matters Under 37 C.F.R. §42.8(b)(2)

Petitioners are not aware of any disclaimers, reexamination certificates, or other petitions for IPR of the '324 Patent. The '324 patent was asserted in *Stratasys, Inc. v. Shenzhen Tuo Zhu Technology Co. Ltd. et al.*, EDTX-2-24-cv-00645 (waiver of service filed on September 11, 2024). That case has been consolidated with EDTX-2:24-CV-644, which involves the same plaintiff and defendants. Additionally, the '324 patent is the subject of a declaratory judgement action (for non-infringement) in *BambuLab USA, Inc. et al. v. Stratasys, Inc.*,

WDTX-1-24-cv-01511 (filed on December 9, 2024). The parties are also involved in concurrent case nos. IPR2025-00257 and IPR2025-00321.

C. Lead And Back-Up Counsel Under 37 C.F.R. §42.8(b)(3)

Petitioner provides the following designation of counsel.

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D. Service Information

Please address all correspondence and service to the address listed above.

Petitioner consents to electronic service by email at IPR56224-0014IP1@fr.com (referencing No. 56224-0014IP1).

Respectfully submitted,

Dated December 18, 2024

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CERTIFICATION UNDER 37 CFR § 42.24

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter partes* Review totals 13,952 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated December 18, 2024

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CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§ 42.6(e)(4)(i) *et seq.* and 42.105(b), the undersigned certifies that on December 18, 2024, a complete and entire copy of this Petition for *Inter partes* Review, Power of Attorney, and all supporting exhibits were provided via Federal Express, to the Patent Owner by serving the correspondence address of record as follows:

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