UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

3D Systems Corporation and 3D Systems, Inc.,
Petitioner,

v.

Intrepid Automation, Inc.,
Patent Owner

Inter Partes Review (IPR) Proceeding Number:

U.S. Patent No. 11,338,511

Exhibit Number: 2015

Exhibit Title: David Rosen, Ph.D., Declaration

Date of Filing: March 19, 2026

Filed by: Intrepid Automation, Inc.

DECLARATION OF DAVID ROSEN, PH.D. IN SUPPORT OF PATENT OWNER

I, David Rosen, Ph.D., declare as follows:

I. QUALIFICATIONS

1. I make this Declaration based upon my own personal knowledge, information, and belief, and I would and could competently testify to the matters set forth in this Declaration if called upon to do so.

2. Attached hereto is a true and correct copy of my Curriculum Vitae (CV).

3. I have over 30 years of experience in the field of additive manufacturing, also known as three-dimensional (3D) printing.

4. I am currently a Principal Scientist at the Agency for Science, Technology, and Research (A*STAR), Singapore, with a primary appointment in the Institute of High Performance Computing (IHPC) and a secondary appointment in the Singapore Institute of Manufacturing Technology. At A*STAR, I lead research projects on additive manufacturing processes and technologies.

5. I hold an Adjunct Professor position at the Singapore University of Technology and Design (SUTD) in the Engineering Product Development Pillar.

6. Previously, I was a Professor at the George W. Woodruff School of Mechanical Engineering at Georgia Institute of Technology and was teaching at the school in some capacity since 1992. I was first employed at the George W. Woodruff School of Mechanical Engineering as an instructor, then as an Assistant

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Professor, Associate Professor, and Professor. I currently hold the title of Emeritus Professor.

7. During my tenure at the George W. Woodruff School of Mechanical Engineering I studied, researched, and advised in the field of additive manufacturing, including teaching the following courses: Introduction to Additive Manufacturing, Rapid Prototyping in Engineering, Finite Element Method, Computing Techniques, and Design Across Disciplines. I was the director of the Rapid Prototyping and Manufacturing Institute, and my responsibilities include, but are not limited to, directing and formulating educational and research programs, coordinating laboratory operations, and supervising student projects in the field of additive manufacturing.

8. During a leave of absence from Georgia Institute of Technology in 2016-2018, I was a Professor in the Engineering Product Development pillar at SUTD. Concurrently, I served as the research director for the Digital Manufacturing and Design Center at SUTD. After returning full-time to Georgia Institute of Technology in 2018, I continued as research director for the Digital Manufacturing and Design Center in a part-time capacity until 2022.

9. I was a visiting professor in the Department of Mechanical and Manufacturing Engineering at Loughborough University in the United Kingdom from 2005 to 2011.

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10. I was also a visiting professor in the School of Mechanical and Aerospace Engineering at Nanyang Technological University in Singapore.

11. I hold a Ph.D. from the University of Massachusetts in Mechanical Engineering. I also hold a Bachelor's and a Master's degree from the University of Minnesota in Mechanical Engineering.

12. While studying at the University of Massachusetts, I was a visiting research scientist at the Ford Scientific Research Laboratory.

13. I have two years of software development experience working on mechanical computer-aided design systems at Computervision Corporation, before starting my Ph.D. studies.

14. As detailed in my CV, I have received numerous awards for my work, including awards from the Solid Freeform Fabrication Symposium, the American Society of Mechanical Engineers (ASME) Design Theory and Methodology Conference, and the ASME Computers and Information in Engineering Division, ASTM International, and the 3D Systems North American User Group. I have also been awarded numerous best paper or best presentation awards at international conferences. Additionally, I received many grants and contracts, as principal or co-principal investigator, relating to, among other things, additive manufacturing, design guidance systems for additive manufacturing, and design for manufacturing.

15. I have published three books, and contributed to chapters in numerous

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other books, on additive manufacturing technologies. I have authored hundreds of publications and presented at hundreds of conferences in the fields of additive manufacturing, engineering design, design for manufacturing, computer-aided design, and geometric modeling.

16. I am a Fellow of the American Society of Mechanical Engineers and served on the Executive Committee of the CIE Division. Also, I am a Fellow of ASTM International and serve as the Chair of the design subcommittee of the ASTM additive manufacturing committee F42.

17. I am an inventor on five patents related to medical devices, fabrication techniques, and haptic interface devices.

18. I have founded two companies, AlpZhi, Inc. and Additive Manufacturing Technologies Inc., both related to stereolithography and 3-D printing software.

19. I have guided dozens of students through their Ph.D. and Master's theses, and served on dozens of thesis and dissertation committees.

20. A copy of my curriculum vitae, including a list of scientific publications and presentations, is attached to this Declaration

II. MATERIALS CONSIDERED

21. The analysis that I provide in this Declaration is based on my education and experience in the field of additive manufacturing, as well as the

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documents I have considered, including the '511 patent [Ex. 1001] and excerpts from its prosecution history [Ex. 1002]. The 511 patent states on its face that it issued from an application filed on March 29, 2021, which claims priority to application 16/938,298 filed on July 24, 2020, now Patent No. 11,014,301, which claims priority to application 16/370,337 filed on May 29, 2019, now Patent No. 10,780,640, application 62/734,003, filed on September 20, 2018, and application 62/711,719, filed on July 30, 2018. For my analysis in this declaration, I will use July 30, 2018 as the priority date. I have cited the following documents in my analysis below:

EXHIBIT NO.	DESCRIPTION
Ex. 1001	U.S. Patent No. 11,338,511 ("the '511 Patent")
Ex. 1002	Excerpts from the Prosecution History of the '511 Patent
Ex. 1003	Yong Chen Declaration
Ex. 1004	U.S. Patent No. 8,666,142, "System and Method for Manufacturing" ("Shkolnik")
Ex. 1005	International Patent Application Publication WO 2017/154564 A1, "Three-Dimensional Shaping Device" ("Sekine") – translated to English and including declaration of Eric Vance (translator)
Ex. 1006	U.S. Patent Application Publication No. 2017/0102679, "Sub-Pixel Grayscale Three-Dimensional Printing" ("Greene")
Ex. 1028	European Patent Application Publication No. EP 3,053,729 A1, "Method for exposing a photo polymerizable material for solidification of material layer by layer to build a 3D object" ("Jorgensen")

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EXHIBIT NO.	DESCRIPTION
Ex. 1029	Yi et al., "Delta DLP 3-D Printing of Large Models," *IEEE Transactions on Automation Science and Engineering*, Vol. 15, No. 3 (DOI: 10.1109/TASE.2017.2751664) ("Yi")

III. LEGAL PRINCIPLES

22. I am not an attorney. For purposes of this declaration, I have been informed by counsel for Intrepid Automation, Inc. about certain aspects of the law that are relevant to my analysis and opinions, as set forth below.

A. Prior Art

23. I understand that the prior art to the '511 patent includes patents and printed publications in the relevant art that predate the '511 patent's priority date. As I explained previously, I have been instructed to assume for purposes of my analysis that July 30, 2018 is the relevant date for determining what is "prior art." In other words, I should consider as "prior art" anything publicly available prior to July 30, 2018. I further understand that, for purposes of this proceeding in the United States Patent Trial and Appeal Board, only patents and documents that have the legal status of a "printed publication" may be relied on as prior art.

B. Claim Construction

24. I understand that under the legal principles, claim terms are generally given their ordinary and customary meaning, which is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the

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invention, *i.e.*, as of the effective filing date of the patent application. I further understand that the person of ordinary skill in the art is deemed to read the claim term not only in the context of the particular claim in which a claim term appears, but in the context of the entire patent, including the specification.

25. I am informed by counsel that the patent specification, under the legal principles, has been described as the single best guide to the meaning of a claim term, and is thus highly relevant to the interpretation of claim terms. I understand for terms that do not have a customary meaning within the art, the specification usually supplies the best context of understanding the meaning of those terms.

26. I am further informed by counsel that other claims of the patent in question, both asserted and unasserted, can be valuable sources of information as to the meaning of a claim term. Because the claim terms are normally used consistently throughout the patent, the usage of a term in one claim can often illuminate the meaning of the same term in other claims. Differences among claims can also be a useful guide in understanding the meaning of particular claim terms.

27. I understand that the prosecution history can further inform the meaning of the claim language by demonstrating how the inventors understood the invention and whether the inventors limited the invention in the course of prosecution, making the claim scope narrower than it otherwise would be.

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Extrinsic evidence may also be consulted in construing the claim terms, such as my expert testimony.

28. I have been informed by counsel that, in IPR proceedings, a claim of a patent shall be construed using the same claim construction standard that would be used to construe the claim in a civil action filed in a U.S. district court (which I understand is called the "*Phillips*" claim construction standard), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.

29. I have been instructed by counsel to apply the "*Phillips*" claim construction standard for purposes of interpreting the claims in this proceeding, to the extent they require an explicit construction. The description of the legal principles set forth above thus provides my understanding of the "*Phillips*" standard as provided to me by counsel.

30. I understand that some claims are independent, and that these claims are complete by themselves. Other claims refer to these independent claims and are "dependent" from those independent claims. The dependent claims include all of the limitations of the claims on which they depend.

C. Anticipation

31. I understand that a patent claim is anticipated if a single prior art

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document describes every element of the claim such that a person of ordinary skill in the art ("POSITA") could practice the claimed method without undue experimentation.

32. I understand that anticipation may be by express disclosure in the prior art. I also understand that if the prior art references does not expressly set forth a particular claim element, the prior art may still anticipate a patent claim if that element is "inherent" in its disclosure—that is, if it is necessarily found in the reference. A property is inherent even if a POSITA would not have appreciated that property as of the date of that prior art.

D. Obviousness

33. I understand that obviousness is a determination of law based on various underlying determinations of fact. In particular, these underlying factual determinations include (1) the scope and content of the prior art; (2) the level of ordinary skill in the art at the time the claimed invention was made; (3) the differences between the claimed invention and the prior art; and (4) the extent of any proffered objective indicia of non-obviousness. I understand that the objective indicia which may be considered in such an analysis include commercial success of the patented invention (including evidence of industry recognition or awards), whether the invention fills a long-felt but unsolved need in the field, the failure of others to arrive at the invention, industry acquiescence and recognition, initial

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skepticism of others in the field, whether the inventors proceeded in a direction contrary to the accepted wisdom of those of ordinary skill in the art, and the taking of licenses under the patent by others, among other factors.

34. To ascertain the scope and content of the prior art, it is necessary to first examine the field of the inventor's endeavor and the particular problem for which the invention was made. The relevant prior art includes prior art in the field of the invention, and also prior art from other fields that a person of ordinary skill in the art would look to when attempting to solve the problem.

35. I understand that a determination of obviousness cannot be based on the hindsight combination of components selectively culled from the prior art to fit the parameters of the patented invention. Instead, it is my understanding that in order to render a patent claim invalid as being obvious from a combination of references, there must be some evidence within the prior art as a whole to suggest the desirability, and thus the obviousness, of making the combination in a way that would produce the patented invention.

36. I further understand that in an obviousness analysis, neither the motivation nor the purpose of the patentee dictates. Rather, any problem known in the field can provide a reason for combining the prior art in the manner claimed.

IV. LEVEL OF ORDINARY SKILL IN THE ART

37. I understand that an assessment of claims of the '511 patent should be

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undertaken from the perspective of a person of ordinary skill in the art as of the earliest claimed priority date, which, as I explained above, I assumed to be July 30, 2018. I have also been advised that to determine the appropriate level of a person having ordinary skill in the art, the following factors may be considered: (1) the types of problems encountered by those working in the field and prior art solutions thereto; (2) the sophistication of the technology in question, and the rapidity with which innovations occur in the field; (3) the educational level of active workers in the field; and (4) the educational level of the inventor.

38. In my opinion, a person of ordinary skill in the art at the time of the alleged invention of the ’511 patent is the same as that proposed by the Petitioner, specifically the person would have had a master’s degree in mechanical engineering, industrial engineering, optics, or a similar field, with course work or industry experience in additive manufacturing; or a bachelor’s degree with a subset of that course work and 2-3 years of additive manufacturing experience.

39. My opinions regarding the level of ordinary skill in the art are based on, among other things, my experience in research and teaching additive manufacturing. Although my qualifications and experience exceed those of the hypothetical person having ordinary skill in the art, my analysis and opinions regarding the ’511 patent have been based on the perspective of a person of ordinary skill in the art as of July 30, 2018.

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V. THE ’511 PATENT

A. Overview of the ’511 Patent

40. The ’511 patent is titled “Multiple Image Projection Method for Additive Manufacturing.” (Ex. 1001, Title.) It issued from an application filed on March 29, 2021, which claims priority to application 16/938,298 filed on July 24, 2020, now Patent No. 11,014,301, which claims priority to application 16/370,337 filed on May 29, 2019, now Patent No. 10,780,640, application 62/734,003, filed on September 20, 2018, and application 62/711,719, filed on July 30, 2018.

41. The ’511 patent is directed to an “additive manufacturing system, and associated methods, comprise an image projection system comprising a plurality of image projectors that project a composite image onto a build area within a resin pool.” (*Id.*, Abstract.) In the additive manufacturing field, the ‘511 patent describes a type of mask projection vat photopolymerization process. This type of additive manufacturing process will be denoted as VPP/MP (for vat photopolymerization / mask projection). ISO/ASTM 52900. In this process type, the projected images define part cross-sections that are projected into a resin pool, where the resin is a reactive photopolymer. That is, the resin reacts when radiant energy of a certain wavelength is incident onto the resin and the reaction produces a solid section of the part.

42. To fabricate a part in an additive manufacturing machine that utilizes the VPP/MP process, one starts with a geometric model of a part. This model is

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sliced into a stack of layers where each layer (also called a "slice") contains a two-dimensional (2D) cross-section of the part. A VPP/MP machine fabricates the part by projecting each layer cross-section into the resin vat sequentially, where the projected cross-section causes the resin to solidify into the shape of the cross-section. After a layer is solidified, the machine moves the part being fabricated such that a new layer of resin coats the previously solidified layer, then the next part cross-section is projected into the resin, and the process repeats for all layers. In this manner, the part is fabricated layer-by-layer.

43. A typical VPP/MP machine will have a light source, an optics system, a means of generating a pattern that contains the part cross-section geometry, a controller (typically includes a PC and possibly other electronics), a resin vat, and a mechanical system to raise or lower the part as it is being fabricated. Of importance here is the light source, optics system, and pattern generator since these are the main components of relevance to the '511 patent. The light source may be a laser, an LED or set of LED lights, a lamp, an LCD screen, or other source. The optics system could consist of one or more lenses or other optical devices.

44. The pattern generator is a key component in the system; it may be a digital micromirror device (DMD), an LCD screen, or other type of device that can project a patterned image. Note that a specific type of DMD is often referred to as DLP in the additive manufacturing field, for the digital light projection technology

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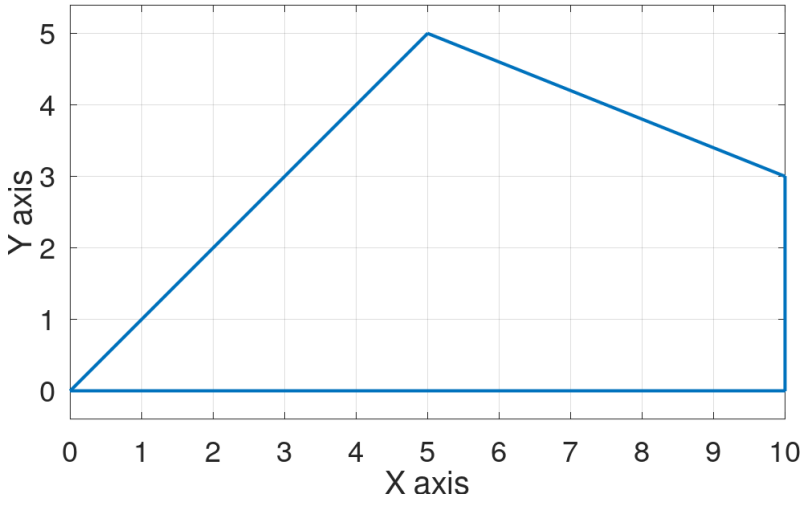
marketed by the Texas Instruments company (DLP is a registered trademark of Texas Instruments). Regardless of the specific pattern generation technology, the projected pattern consists of an array of pixels (short for picture elements) which are (typically) square areas of projected light. Thus, the part cross-section shape is approximated by an array of squares in a projected image. An example is shown in Illustration 1a, where the part cross-section geometry corresponds to the thick blue lines. The dim grid pattern represents the pixels which, in this case, are one unit in size. Illustration 1b, in contrast, is the projected image of the part cross-section where a pixel is "on" (white) if it is at least half filled by the part cross-section geometry. Part boundaries represented by slanted line segments are approximated by the pixels. Antialiasing techniques seek to adjust intensities (determine a shade of gray, instead of white or black) along these part boundaries to reduce the "jagged edges" in the image. The projected image in this example is a very low resolution image for illustration purposes.



a)

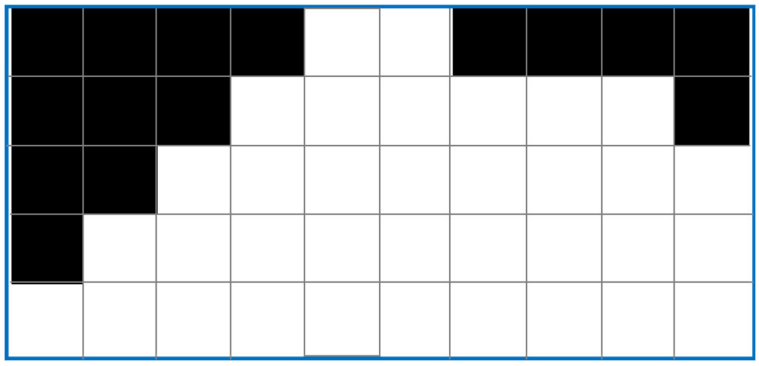
b) 

Illustration 1. Example of a part cross-section in (a) approximated by an array of pixels in (b).

45. If the projection system is set up so that these square pixels are very small, then part cross-section shapes can be approximated with very small errors. However, for a given pattern generator size, for example 1920x1080 pixels in size, a smaller projected pixel size causes the total image size to be smaller. For example, if the projected pixel was 0.05x0.05 mm in size, then the total projected image size would be 96x54 mm. This represents the largest part cross-section that could be projected into the resin vat. Although this may be large enough for some parts, other parts will be larger than this size so could not be fabricated with only one projector unless other provisions were made in the VPP/MP machine to accommodate large parts.

46. One approach to enable fabrication of parts larger than, for example 96x54 mm, is to use multiple projectors. If two projectors were used side-by-side, then one configuration could fabricate parts up to 192x54 mm in size. If four

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projectors were arrayed in a 2x2 configuration, then a cross-section size up to 192x108 mm would be possible. And additional projectors could be added to yield an even larger part fabrication capability while maintaining the same process resolution of the 0.05x0.05 mm projected pixel size.

47. Another approach would be to change the optical system to magnify the pixel size, but this causes a reduction in process resolution and a resulting loss in fabricated part accuracy. By applying a magnification of 2X, one 1920x1080 projector could project an image that is 192x108 mm in size, but with a process resolution of 0.1 mm instead of 0.05 mm.

48. The ‘511 patent addresses issues that arise when an array of projectors is used in a VPP/MP system that is intended to fabricate large parts with high resolution. Issues include nonuniform “brightness” of a projector, different levels of brightness between different projectors, distortions in images, alignment mismatches between adjacent images, and others. The ‘511 patent proposes solutions to many of these issues.

49. Specifically, the '511 Patent claims a novel, non-obvious solution to the issues that arise in multiple-projector additive manufacturing. In the ’511 Patent, a “stack” (or “set”) of four types of digital filters are applied to a projected image containing a part cross-section. These digital filters adjust the light from projectors such that when the light impinges on the resin, the resin solidifies in the

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desired manner. The stack of four digital filters is shown in FIG. 2A from the '511 patent which is repeated below for convenience. The stack of filters includes a warp correction filter 210, which performs geometric correction (adjusting the placement of the pixels incident on the surface to account for distortions), a gamma adjustment mask filter 220, a filter with edge blending bars 230, and an irradiance normalization filter 240. The latter three filters manage the intensity of the projected light in different ways to accomplish different purposes: (i) the irradiance mask that normalizes radiant power per unit area (i.e., irradiance) across a sub-image or composite image; (ii) the gamma adjustment mask maps pixel intensity levels to an addressable range of energy for curing the resin; and (iii) a blending bar filter on one or more of the sub-image edges that controls how neighboring projected sub-images work together to ensure that transitions between sub-images are managed to yield the desired part properties.

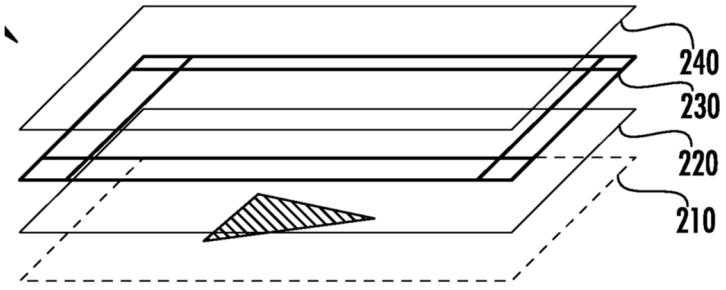

FIG. 2A

50. In this context, a filter is a computer or software embodiment of adjustments or corrections to be made to a projected image. The projected image

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could be a sub-image from one projector or a composite image. The filter could be embodied as an array of values that get combined with irradiance values in an image. Or, a filter could be embodied as an equation or other quantitative representation that is applied to an image.

51. Importantly, the ’511 Patent’s stack of digital filters work as a set – each adjustment has a cascading effect on the other properties. Further, the ’511 Patent’s filter-based approach is designed for production manufacturing. Unlike prior art systems, the ‘511 Patent’s filter stack does not require modification of the base source file that contains part geometry information, such as the sliced part cross-sections (stack of slices) and other instructions for part fabrication. Instead, the ’511 Patent’s digital filters are applied (or overlaid) to a base source file rather than changing the base file itself, which is advantageous because different filters can be used in different situations, or changed periodically, without changing the base source file. ’511 Patent at 4:23-32.

52. Further, the use of sensors on the VPP/MP machine enables updating the filters during part fabrication or machine usage. This is in contrast to the typical approach used for preparing executable instruction files for part fabrication in single-projector VPP/MP machines, and AM machines in general. Typically, “build preparation” (process for converting part geometry files into executable machine files, called “source files” in the ‘511 patent and the Patent Owner

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Response) is performed using software that slices parts into layers, performs any adjustments and corrections needed, assigns process parameter values, and saves the fabrication instructions in a computer file that is subsequently transferred to the VPP/MP machine. Using this approach, it was impossible to compensate for changes in the VPP/MP machine, such as a light source becoming dimmer or DMD micromirrors heating and distorting, without updating the build preparation software and modifying the source files. In contrast, the digital filters in the '511 patent can be updated easily to adjust or correct for VPP/MP machine changes without requiring software updates or upgrades that would be used to modify the source files.

B. Claim Construction

53. As mentioned above, I understand that a claim term is generally given its plain and customary meaning to a POSITA at the time of the invention. Moreover, the POSITA is deemed to read the claim term not only in the context of the particular claim in which it appears, but in the context of the entire patent, including the specification.

54. One particular claim term of note here is "normalize irradiance." This term appears in independent claim 1. Claim 1 requires "an irradiance mask that normalizes irradiance."

55. A POSITA at the time of the invention would understand that the

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irradiance mask recited in the independent claim of the ’511 Patent normalizes radiant power per unit area (i.e., irradiance) across a sub-image or composite image. The standard meaning of the word “normalize” is to bring or return to a normal or standard condition. In the context of projected patterns, the standard condition is interpreted as uniform irradiance.

56. Regarding the ‘511 patent, one method to achieve uniform irradiance is to determine the range of irradiances produced by the projectors in an array of projectors and divide the irradiance values across the array by the maximum irradiance produced by the brightest projector. Then, the irradiances across the projector array are expressed in the range from 0 to 1. After this operation, the irradiances can then be mapped to a convenient range for controlling projected image irradiances. Since many DLP system controllers use 8-bit digital words, a convenient range to express irradiances is 0 to 255 (2^8).

57. As explained in the specification of the ’511 patent, normalizing the irradiance of an image causes the image to have a uniform irradiance range across the entire image. *See* ’511 patent, 11:24-30 (“Another example of a type of digital filter that can be used to adjust an image is an irradiance masking filter, where the filter applies a normalizing irradiance mask to an image (or each sub-image in a composite image) such that the image (or composite image) has a uniform irradiance range (i.e., from zero exposure to a maximum exposure limit) across the

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area.") (emphasis added); '511 patent, 23:25-26 (irradiance mask adjusts irradiance to "create a uniform irradiance across the whole image.") (emphasis added). This definition of irradiance normalization is consistent with Dr. Chen's description and is consistent with what a POSITA would understand. ("the dimmest pixel is used as the baseline for all of the other pixels, such that all pixels (once "normalized") have uniform brightness."). [Chen ¶ 50]

58. It may be helpful to use an example. Example 1 in the '511 patent is given as:

Example 1: Irradiance Mask

> In this example, an image projector outputs across its projected area a solid white image where, when measured (e.g., by a calibration fixture described herein), the pixels in the top left corner are 5% less bright (i.e., 5% lower irradiance) than elsewhere in the field of view. An irradiance mask is applied that acts as a "burn filter" (i.e., a filter that decreases or increases the irradiance in a pattern, locally, or uniformly across an image). The irradiance mask, when applied to the solid white image, brings the 100% bright pixels elsewhere in the image down to 95% in order to create a uniform irradiance across the whole image.

59. This example can be visualized using Illustration 2. An image projector output, shown in Illustration 2a, is an example where the irradiance at the upper left corner is 95 units, while the irradiance at the other corners is 100 units

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(the grayscale range has been exaggerated for ease of visualization). As stated in the example, a "burn filter" is introduced to ensure that the projected image has an equal level irradiance across the entire image, i.e., a uniform irradiance distribution. The filter, shown in Illustration 2b, allows 100% of the irradiance to propagate through it in the upper left corner, while imposing a restriction to allow only 95% of the irradiance through most of the image. Note that the filter is specified by irradiance values between 0 and 1. If it is assumed that the DLP controller uses 8-bit words, then the irradiance values are mapped to the range of 0-255. As a result, the projected image from the projector in Illustration 2a would have a uniform irradiance of 242 (95% of 255), as shown in Illustration 2c.

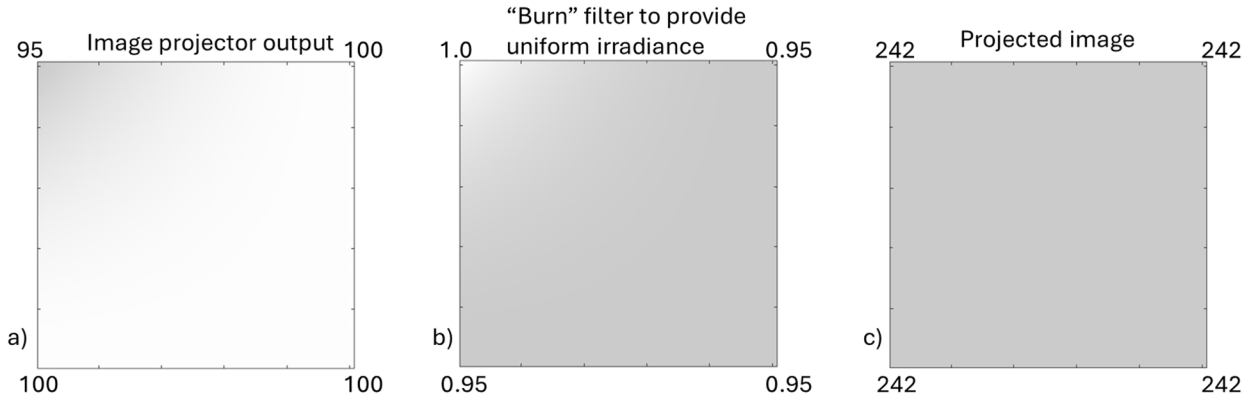

Illustration 2. Example 1 visualization showing a) image projector output with the upper left corner dimmer than the rest of the image, b) an irradiance normalization filter that provides c) uniform irradiance.

VI. PETITIONER'S PROPOSED INVALIDITY GROUNDS FAIL

A. Ground 1 Fails

60. In Ground 1, Petitioner contends that claims 1-8, and 14-15 of the

’511 Patent are anticipated by U.S. Patent No. 8,666,142 (“Shkolnik”) [Ex. 1004]. In my opinion, Shkolnik fails to anticipate the claims of the ’511 Patent.

1. Shkolnik does not disclose “an irradiance mask that normalizes irradiance” (Claims 1-8, 14-15)

61. One issue raised in the Petition is whether Shkolnik discloses an irradiance mask. As mentioned above, A POSITA at the time of the invention would understand that the irradiance mask recited in the independent claims of the ’511 Patent normalizes radiant power per unit area (i.e., irradiance) across a sub-image or composite image.

62. In my opinion, Shkolnik does not disclose an irradiance normalization filter as described here. Shkolnik discusses intensity compensation or intensity adjustment. For example, “the intensity value may be compensated or adjusted before being sent to the pattern generator, or may be compensated or adjusted at the pattern generator, or both.” Shkolnik 9:48-51. Shkolnik describes how intensity values may be determined based on the reactive material’s characteristics and the nature of the computer system used to control the projectors or pattern generator. The presentation includes references to intensity and exposure time parameters to control the total exposure that is incident on the reactive material. Two examples are given to determine intensity and exposure time parameter values individually. The first is “when a source 142, 144 has a fixed intensity (such as a laser), the time the source is “on” may be modulated to produce a total exposure value.” Shkolnik

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10:8-11. For this type of additive manufacturing system, the "total exposure" is determined by multiplying the irradiance value and the time that the irradiance is on. *See* Shkolnik 10:20-22 and the '511 patent equation (2). The second example is: "Alternatively, where the time of exposure is a predetermined value, the intensity of source 142, 144 may be modified produce the desired total exposure value." Shkolnik 10:11-13. It is also possible to vary both the irradiance (intensity) and exposure time. The presentation continues with a discussion of voxel-level control of "total exposure." Shkolnik 10:14-33.

63. In summary, the treatment of intensity compensation or adjustment focuses on how to specify intensity values, that intensity is related to the reactive material's characteristics, that intensity is one of two parameters that controls total exposure received by the reactive material, and that this total exposure should be controlled at the voxel level. The presentation does not discuss making the intensity or irradiance uniform across the projected image, that is, does not describe irradiance normalization. Nor does the presentation disclose the use of an irradiance normalization mask or filter.

64. Petitioner claims that "Shkolnik specifically teaches adjusting irradiance to match an 'ideal,' 'standard,' 'compensation,' or 'normalized' irradiance—all of which the POSITA would treat as meaning the same thing." Chen ¶ 144. This statement is not true.

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65. Shkolnik uses the term 'ideal' when discussing geometric correction. For example, in the first usage of the word "ideal," Shkolnik discusses the generation of a pattern correction map by comparing an "uncompensated test pattern" with "the ideal (or expected) test pattern to generate a pattern correction map." Shkolnik 5:45-46. The patent goes on to explain that this applies to positional compensation and adds a clause about intensity compensation: "This pattern correction map may include positional compensation (e.g., to adjust linear and nonlinear distortions) and may also provide for intensity compensation." Shkolnik 5:47-49. But, then Shkolnik returns to positional compensation in the next sentence: "In general, the compensation may include X and Y positional offsets for each pixel associated with a bitmap." Shkolnik 5:49-51. No further instructions are provided regarding intensity compensation so it is not clear when, where, or how this could be achieved.

66. The Shkolnik patent contains many references to "ideal calibration template," "ideal calibration pattern," and similar phrases. Shkolnik 14:39, 15:1, 16:21-22, etc. These phrases are all used in the context of positional correction or removing distortions, not irradiance normalization.

67. Shkolnik uses the term "standard" only one time in reference to intensity, but this is in reference to edge blending. Shkolnik 34:15-28. Indeed, the reference refers to the adjustment of projector intensities so that the overlap region

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is not overexposed: “If desired, both pattern generators 102, 104 could generate overlap regions 724, 734 and to avoid over exposure, could each reduce the intensity of output so that the combined intensity is standard.” Shkolnik 34:19-23. This is clearly not disclosing how to ensure that an entire image has uniform irradiance across its entire span.

68. Shkolnik uses “normalization” only once to refer to normalizing the thickness of the *resin* (“reactive material”) within a 3D printer, not intensity of light. Specifically, the usage was: “The photopolymer may be laid, the thickness normalized, and transported to a moveable platform/support plate 112.” Shkolnik 35:29-31. Clearly, this is not a reference to irradiance normalization. In fact, the usage refers to the resin recoating process to achieve a uniform coating of new resin on the previously solidified layer. The recoating operation is completely independent of the adjustment of projected images to achieve uniform irradiance.

69. The overall conclusion is that Shkolnik fails to disclose irradiance normalization as described in the ‘511 patent or as understood by a POSITA.

70. Indeed, a POSITA reading Shkolnik would understand that Shkolnik is directed to geometric correction and calibration, not irradiance normalization. FIGs 1E, 1F, and 1G present high level flowcharts of several “work piece construction method(s)” with “on-the-fly calibration/correction of the pattern generators.” These flowcharts refer to finer details in FIGs 1B, 1C, and 1D.

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Notably, FIGs 1E, 1F, and 1G contain items "Calibrate Imager" 1100, "Calibrate Pattern Generator(s)" 1200, and "Generate Patterns(s)" 1300 and FIGs 1B, 1C, and 1D provide more detailed steps for how to achieve each of these items, respectively. FIG. 1E is reproduced below for convenience.

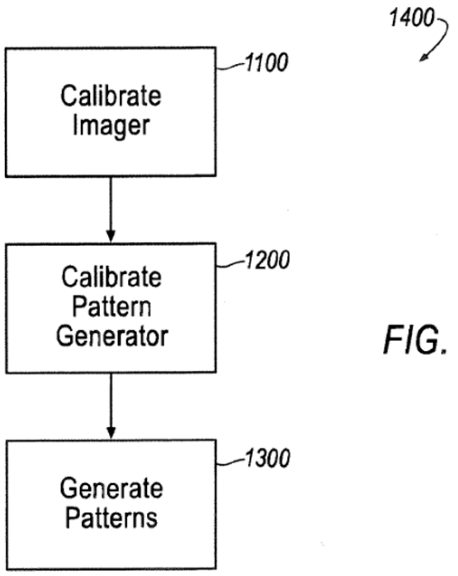

FIG. 1E

71. FIG. 1B includes five items (repeated below). In the Shkolnik patent, the "imager" is part of the calibration system for pattern generators. It is referred to as a camera in parts of the patent, for example 5:42 and 6:52. When one reads the patent description in Shkolnik, the purpose of imager calibration seems to be to "correct[ed] for linear and non-linear inaccuracies and for the imager's position (e.g., off axis placement)." Shkolnik 6:56:58. These linear and non-linear inaccuracies are for the imager, not a pattern generator, so they do not refer to capturing or correcting irradiance nonuniformities. Rather, this is to adjust for

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imperfections in the imager/camera.

72. Furthermore, the imager calibration steps utilize a "known calibration template 310" (Shkolnik 13:30) and addresses geometric corrections; none of these items address irradiance normalization. Imager calibration can result in images being "adjusted and corrected for linear and non-linear inaccuracies." Shkolnik 13:33-34. Subsequently, it becomes clear what types of linear and non-linear inaccuracies are being considered. Specifically, "scaling operations may be performed to compensate" (Shkolnik 13:46-47) and "rotation (e.g., 90 degrees) and scaling may be applied" (Shkolnik 14:27-28) specify geometric corrections, not irradiance corrections. This is consistent with the later statement regarding the content of a calibration template 310 as, for example, "a printed checkerboard with a large number of black and white squares" Shkolnik 14:44-45. This type of calibration template is only suitable for geometric correction or calibration as described in Shkolnik. *See* Shkolnik 14:46-67, 15:1-25. Accordingly, a POSITA would recognize that the general calibration template, and the specific checkerboard pattern, would be appropriate only for geometric correction or calibration, but would be ineffective for irradiance correction or calibration.

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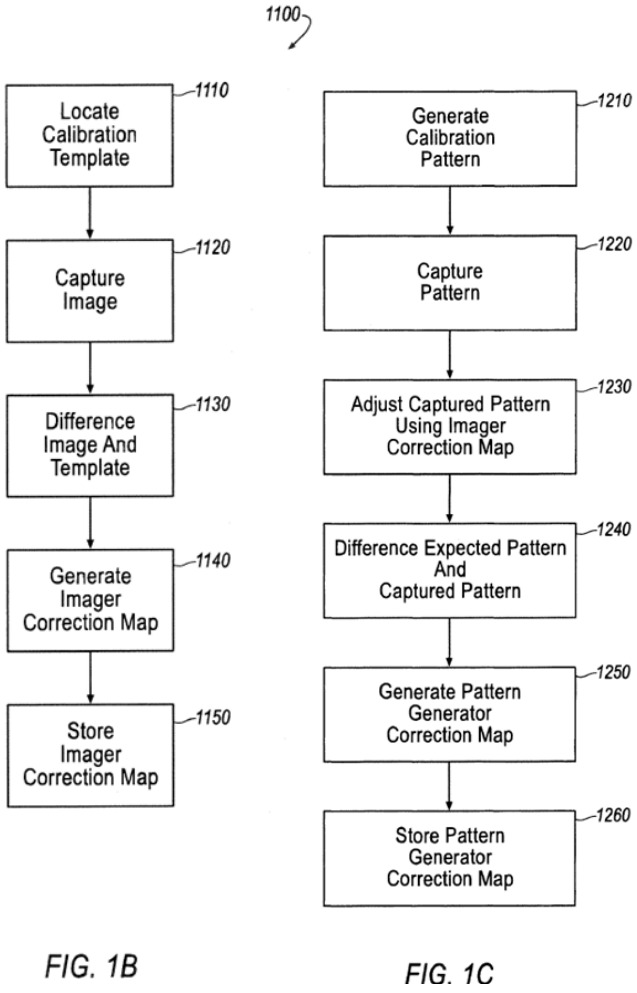

FIG. 1B

FIG. 1C

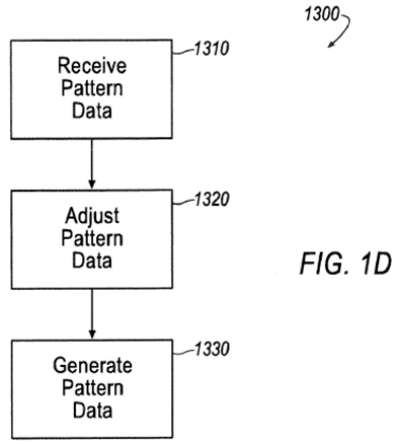

FIG. 1D

73. With reference to FIG. 1E, item "Calibrate Pattern Generator" 1200 is expanded in FIG. 1C. Similar to FIG. 1B, the sequence of items in FIG. 1C produces another correction map, in this case a "Pattern Generator Correction Map" 1260. The text description of FIG. 1E, 1F, 1G, and 1C discloses approaches and methods for generating a pattern generator correction map, including how to measure imperfections in the pattern generator, comparing these imperfections to ideal patterns, and generating and storing these maps.

74. The discussion of FIG. 1C starts at 15:36 and ends at 18:59. The

majority of this discussion focuses on geometric correction issues and not irradiance or "intensity" issues. This is evident in the discussion, for example "The pattern generator correction mapping may then be used to correct each bitmap or the voxel data so that the pattern generators provide an undistorted pattern" (Shkolnik 15:46-49) since pattern distortions are corrected. Also, there is again discussion of a checkerboard pattern used for calibrating patterns, Shkolnik 15:62-64, as well as a reference to "black & white squares" as a calibration pattern 16:28-29 which would be used for geometric corrections. A "mesh-type correction map" is given as a table of pixel-by-pixel geometric corrections (Shkolnik 16:54-63) which, again, is not related to irradiance or intensity.

75. Intensity correction is addressed in this presentation at Shkolnik 18:1-59. However, this is in the context of using grayscale imaging for "a voxelized construction process" where "both the position and the intensity (e.g., a grayscale value) may be adjusted to correct for linear and nonlinear distortions." Shkolnik 18:2-4. Importantly, Shkolnik continues to explain the adjustment and correction process as a method for "achieving sub-pixel features." Shkolnik 18:5. This can be seen readily in the next sentence: "in voxelized construction, grayscale values may be used where facets of the design (e.g., the component or part to be constructed as described for example by an STL file) volumetrically intersect with a voxel volume." That is, this discussion is about analyzing the part model and fine-tuning

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the irradiance levels to provide a desired level of accuracy on a voxel-by-voxel basis. Notably, this is not irradiance normalization across a projected image. Furthermore, it is not a description of an irradiance normalization mask or filter, which is a digital filter that adjusts irradiance values across a projected image to ensure uniformity. Additionally, an irradiance normalization mask is determined from projector and image generator characteristics but is independent of a specific part's geometry. Again, Shkolnik does not disclose normalizing irradiance in this discussion, or anywhere else in the patent.

76. In the "Generate Patterns" 1300 step from FIG. 1B and detailed in FIG. 1D, Shkolnik discusses "a pattern adjustment method." Shkolnik 18:60. In step 1320, the ideal patterns that describe the three-dimensional object that is to be fabricated "are modified by the pattern generator calibration/correction maps determined in method 1200." Shkolnik 19:5-7. Then Shkolnik describes the type of modification that is performed in the "Generate Patterns" 1300 step: "The modification may include simple translation or it may include a complete two-dimensional mapping of the image to compensate for geometric distortion of the pattern generator." Shkolnik 19:8-11. The purpose of the modification is to perform geometric corrections in the pattern generator, not intensity or irradiance correction. The "Generate Patterns" 1300 step does not disclose irradiance normalization or an irradiance normalization mask or filter.

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2. Shkolnik does not disclose a "a gamma adjustment mask that adjusts sub-image energy based on a reactivity or resin in the resin pool" (Claims 1-8, 14-15)

77. The '511 patent discloses a stack of digital filters that adjusts the properties of projected images. One of these filters is a gamma adjustment mask that controls irradiance levels based on the reactivity of the resin from which a part will be fabricated. The gamma adjustment mask is constructed based on the characteristics of the resin and the optics system of the additive manufacturing machine. The gamma adjustment mask is independent of the geometry of any specific part or part cross-section.

78. More specifically, the '511 patent states that the gamma adjustment mask "provides resin reactivity leveling, and enables correct smoothing (and/or antialiasing) of pixels by mapping the pixel intensity range (e.g., 0-255) to the minimum and maximum reactivity characteristics of the pixel." *Id.* 12:8-12. The references to pixels here are to pixels in projected images, not pixels within a part cross-section. That is, with reference to FIG. 2A in the '511 patent, the gamma adjustment mask is indicated as filter 220 in the filter stack. It can be seen clearly that the gamma adjustment mask does not contain part-specific information, which is only in the bottom layer of FIG. 2A (the part cross-section, which is NOT one of the digital filters).

79. FIG. 14 in the '511 patent presents a flowchart of one method for

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gamma correction for use in a gamma adjustment mask. This procedure starts with a set of physical experiments to relate energy incident on the resin to the cured thickness of the solidified resin. This would be recognized by a POSITA as the experiments needed to determine a resin's working curve that relates exposure E' received by the resin to the resin's cure depth D_p. Typically, the experiments are performed for a range of exposure levels up to some maximum level, denoted E'_{max}, that could be defined by the projectors and optical system in the additive manufacturing system. From the working curve, the resin's depth of penetration P_d (constant m_1 in the '511 patent) and critical exposure E'_0 can be determined. These parameters characterize the resin's curing behavior[1].

[1] Note that in additive manufacturing literature, the symbol C_d typically denotes cure depth, while the symbol D_p denotes depth of penetration. The '511 patent used D_p to represent cure depth so that terminology will be used here.

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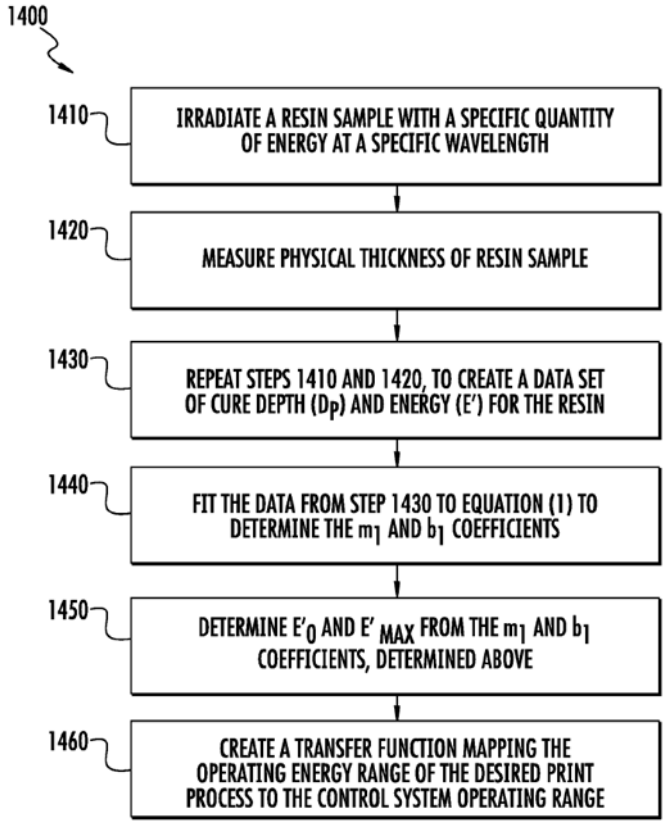

FIG. 14

80. The working curve relationship between exposure and cure depth is typically modeled as logarithmic, as presented in equation (1) in the '511 patent and illustrated in Illustration 3 that indicates how depth of penetration P_d and critical exposure E'_0 are determined. That is, cure depth is plotted against the natural logarithm of exposure. The X-intercept of the working curve is denoted the critical exposure E'_0 since this is the amount of exposure that does not quite cause the resin to solidify; if exposure is increased a little, then solidified resin results. The depth of penetration P_d is the slope of the working curve.

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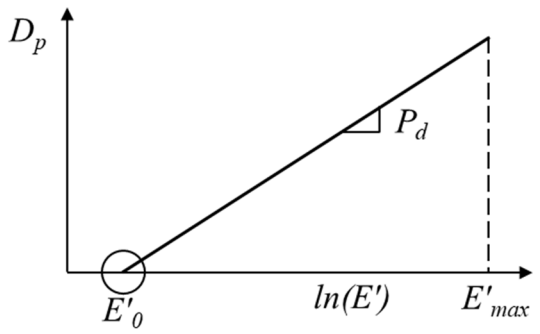

Illustration 3. Example of a resin working curve that relates cure depth to the natural logarithm of exposure. Resin constants E'_0 and P_d can be determined from the working curve.

81. Step 1460 in the gamma adjustment flowchart in FIG. 14 creates a "transfer function mapping the operating energy range of the desired print process to the control system operating range." The objective of this step is to take advantage of the full dynamic range of pixel intensity levels (e.g. 0-255 for an 8-bit system) that will yield cured resin. From the working curve, the minimum and maximum exposure values are known (E'_0 and E'_{max}, respectively). The objective is to map these values to the selected pixel intensity range (0 to 255 in this presentation, although the range could be different). The transfer function identified in step 1460 is given in the '511 patent as equation (7), which is repeated here.

$$E' = E'_0 * (E'_{max}/E'_0)^{L/255} \qquad (7)$$

82. With this relationship, after the desired exposure for a pixel or voxel is known, the pixel intensity value L can be determined easily by solving equation (7) for L.

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83. The gamma adjustment mask is embodied as the relationship in equation (7). This gamma adjustment represents the range of exposure levels of interest for a given resin (and could be tuned to a specific additive manufacturing system) using the full range of intensity values (0-255). It takes maximum advantage of the grayscaling offered by the intensity value range to maximize fabrication accuracy. Furthermore, the gamma adjustment mask depends on the characteristics of the resin and the additive manufacturing system but does not depend on the specific part being manufactured.

84. In contrast, Shkolnik does not discuss gamma adjustment or correction and does not disclose a gamma adjustment mask. In fact, the terms "gamma adjustment" and "gamma correction" do not appear in the Shkolnik patent. Shkolnik refers to a reactive material in reference to the resin but does not discuss a resin's reactivity characteristics. No reference is made to critical exposure or depth of penetration and no models relating exposure or intensity level to cure depth are offered, unlike the '511 patent.

85. Shkolnik discusses in depth various geometric corrections that could be made to adjust the patterns used to fabricate a part. A POSITA would recognize them as relating to improving part accuracy through antialiasing. These correction methods are applied to part cross-sections to adjust their positions and shapes, as well as to fine-tune the exposure received by voxels. The methods also help to

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fabricate smooth surfaces. In short, these are antialiasing methods, not gamma adjustment methods.

86. One example of an antialiasing method described in Shkolnik 18:1-42 proposes a "voxelized construction method" where "both the position and the intensity (e.g., a grayscale value) may be adjusted to correct for linear and nonlinear distortions." Shkolnik 18:2-4. The antialiasing method seeks to achieve "sub-pixel features during the build process." Shkolnik 18:5. To determine the intensity (irradiance) for a specific voxel, the intersection of the voxel with the part model is analyzed. Shkolnik refers to "grayscale values," not irradiance or intensity, in the discussion, but it is clear that grayscale values can be related to exposure levels ('511 patent equation (7)) and irradiance. Specifically, Shkolnik states: "grayscale values may be used where facets of the design (e.g., the component or part to be constructed as described for example by an STL file) volumetrically intersect with a voxel volume." Shkolnik 18:6-9. And, "Each voxel's intensity in the build envelope may then be determined as the volume intersection of the work piece (e.g., using the STL file) within each voxel cuboid." Shkolnik 18:26-28. An example explains that if a "work piece occupies 50% of the voxel, the intensity value for that voxel may be determined to be 50%." Shkolnik 18:29-30. The patent goes on to clarify that the "percent intensity value assigned to a voxel is material dependent, and that there may not be a linear relation between

them." Shkolnik 18:33-35. Shkolnik identifies that intensity is material dependent but does not identify the nature of the dependence or relevant material properties. Methods are needed "to correct for linear and nonlinear distortions," (Shkolnik 18:3-4) but these linear and nonlinear distortions related to materials are not identified and no methods were proposed to solve them. On the other hand, the gamma adjustment mask of the '511 patent is the proposed solution. Shkolnik does not disclose a gamma adjustment mask in this discussion.

87. Shkolnik goes on to describe a number of antialiasing techniques, related to geometric corrections, to achieve sub-pixel features and improve part accuracy and surface smoothness. These techniques are applied to determine appropriate intensities for either two-dimensional pixels or three-dimensional voxels to achieve smooth flat or curved surfaces and mitigate the "jagged edges" problem.

88. Shkolnik provides an example of pixel-based geometric correction in FIG. 1L that can be applied to "voxelized construction methods and/or slice-based construction methods." Shkolnik 23:32-33. Then the patent goes on to present a number of different geometric correction methods for voxel data that provides finer detail features than the pixel-based correction method of FIG. 1L. Specifically, FIGs. 1MA-1MF present a geometric correction example that utilizes grayscale imaging with intensity (irradiance) values given from 0 to 255. FIGs. 1MA-1MC

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show an example of how to determine a part boundary from given intensity values in voxels. The patent argues that if the intensity in a voxel is at the maximum intensity value (e.g., 255), then it must be inside the part volume, which makes sense since this maximum intensity would be used to solidify (cure) the resin at that location. On the other hand, if a voxel has a low intensity value, such as voxel G22 in FIG. 1MA, which has a value of 30, then this voxel is likely to be outside of the part volume. Voxels with intermediate intensity values, such as voxels G21 and G23 (210) will lie on the part boundary. As described earlier, the voxel construction method determines the intensity for a voxel by determining the percentage of the voxel that is inside the part volume. This percentage can be determined using Eqn. (1):

$$\text{Intensity}\% = \frac{Ir - Ir_{min}}{Ir_{max} - Ir_{min}} \times 100 \qquad (1)$$

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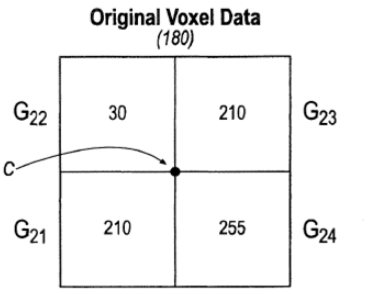

FIG. 1MA

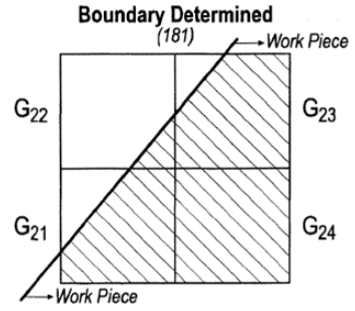

FIG. 1MB

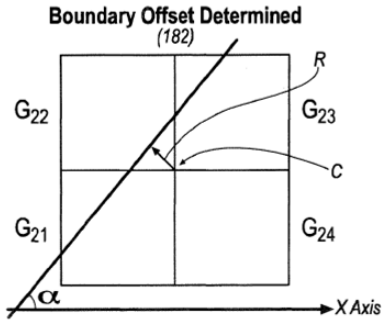

FIG. 1MC

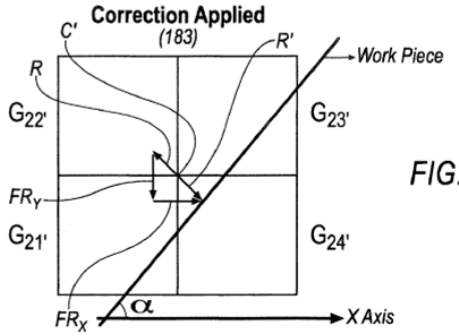

FIG. 1ME

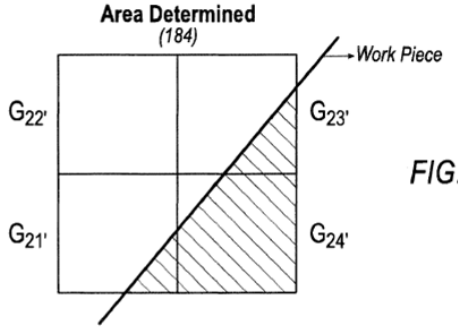

FIG. 1MF

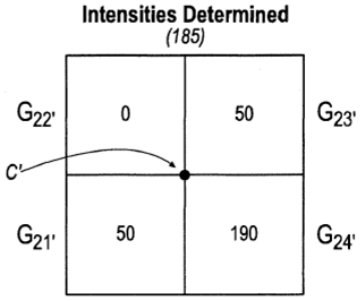

FIG. 1MG

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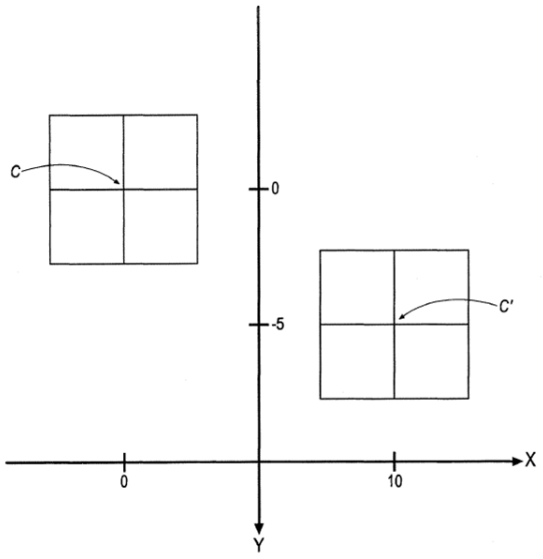

FIG. 1MD

89. In Eqn. (1), *Ir* is the irradiance of the voxel, Ir_{min} is the minimum irradiance value (0) and Ir_{max} is the maximum irradiance value (255). So, the percentage of voxels G21 and G23 that are inside the part is 82% and the percentage of voxel G22 that is inside the part is 12%. Hence, the part boundary can be determined by a line that crosses voxels G21 and G23 that results in approximately 82% of the voxels being inside the part (shown as the cross-hatched region in FIG. 1MB) and that results in approximately 12% of voxel G22 being inside the part. The part boundary is indicated as the darker line labeled "Work Piece."

90. FIG. 1MC illustrates one method for determining a boundary offset from the center point labeled *C* to the part boundary line. This part boundary line

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has an angle of α (alpha) with respect to the X-axis. The minimum distance between point *C* and the part boundary is denoted *R*.

91. FIG. 1MD shows geometric correction that will be applied to the part boundary. In this example R = (10.5, -5.25), indicating a shift in the X and Y axis directions of 10.5 units and -5.25 units, respectively. The figure indicates that the correction will be adjusted by rounding the shift quantities to the nearest integer value. Hence, the geometric correction shifts point *C* to point *C′* by 10 units in the X direction and -5 units in the Y direction.

92. FIG. 1ME illustrates this geometric correction applied to the part boundary, keeping the part boundary angle the same value of α. The voxels are relabeled G21′ to G24′ to indicate that their intensities have changed.

93. FIG. 1MF shows these relabeled voxels with the part boundary line and the region inside the part shown cross-hatched. The procedure illustrated in FIG. 1MA-1MC can be reversed to determine the intensity values for the new part boundary location. Eqn. 1 can be solved for *Ir* and the percentage of the voxels determined that lie inside the part volume. This percentage can be taken as the Intensity% in Eqn. 1, which enables the intensity value *Ir* to be computed. Results are shown in FIG. 1MG. Since voxel G22′ is completely outside the part, it is given an intensity value of 0. Voxels G21′ and G23′ have a small percentage of their volume within the part so they are given an intensity value of 50. Since much

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of voxel G24′ is inside the part, its intensity value was computed as 190.

94. This example illustrates one type of geometric correction disclosed in Shkolnik. It is notable that this is purely a geometric correction applied to voxels, but does not take into account resin characteristics. Gamma adjustment or correction relies on consideration of resin characteristics. Hence, this example does not describe gamma adjustment. Furthermore, a gamma adjustment mask as disclosed in the ‘511 patent relies only on resin characteristics, but does not consider part-specific geometry. The Shkolnik example is based on reasoning about part boundary locations and the extent of overlap between part volume and voxels, and thus, clearly relies on part-specific geometry. Hence, the example does not present the application of a gamma adjustment mask.

95. FIGs. 1MAB-1MGB describe a similar geometric correction example that assumes binary imaging; that is, pixels can only be in either the “off” or “on” positions. No intermediate values are enabled. The procedure followed in this example is similar to that used in FIGs. 1MA-1MG and will not be repeated here. Again, the example does not disclose gamma adjustment or a gamma adjustment mask.

3. The system of the proposed combination does not disclose “further comprising a system controller that synchronizes exposure control of the plurality of image projectors with each other” (Claim 8)

96. The word “synchronizes” means that events happen simultaneously.

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In the context of exposure control with a plurality of image projectors, the meaning of the phrase "synchronizes exposure control of the plurality of image projectors with each other" means that the image projectors project images simultaneously in a coordinated manner. Furthermore, claim 8 discloses a system controller that "synchronizes exposure control," meaning that claim 8 applies to system operation when exposure control is important, which is during part fabrication.

97. Notably, Shkolnik does not use the word "synchronize," "synchronization," or any other variation of the word. Nor is the word "coordinated" used. The word "simultaneously" is used once but in the context of calibrating multiple pattern generators ("By calibrating multiple pattern generators simultaneously, the time for calibration is reduced, and the speed of the system is increased." Shkolnik 32:55-57). This description has nothing to do with coordinating (i.e., synchronizing) the actions of multiple image projectors during part fabrication.

98. Petitioner's argument for claiming that Shkolnik discloses the use of a controller to synchronize a plurality of pattern generators to simultaneously project multiple sub-images does not point to any content in the Shkolnik patent to support the argument:

> Shkolnik discusses that "In general, an application of the system and method described herein may *use a pattern generator* to build a three-

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> dimensional object by exposing a reactive material…" EX1004, 4:48-52. Shkolnik further comprises a "controller" that "receives and sends patterns to pattern generators that selectively produce patterns to produce a work piece" where components work "with controller 120 and pattern generators to produce a solid uninterrupted component." Id., 8:10-17. Chen ¶208.

Petition page 42.

99. It is notable that this text from Petitioner does not disclose anything about synchronized, coordinated, or simultaneous actions concerning the control of multiple pattern generators or image projectors.

100. Hence, Shkolnik does not disclose a "system controller that synchronizes exposure control of the plurality of image projectors with each other."

B. Ground 2 Fails

101. In Ground 2. Petitioner contends that claims 1-8 and 14-15 of the '511 Patent are obvious in view of International Patent Application Publication WO 2017/154564 A1 ("Sekine") [Ex. 1005] together with U.S. Patent Application Publication No. 2017/0102679 ("Greene") [Ex. 1006].

1. Summary of Sekine Patent

102. In the "Problem to be Solved by Invention" (Sekine [0005-0007]), Sekine identifies the issues regarding the loss of resolution when magnifying an image and proposes to "arrange a plurality of image projection means" (Sekine

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[0007]) to maintain resolution while expanding the projected image area. Then, Sekine identifies a resulting problem as "streak patterns or slits in the shaping direction are formed on the surface of the shaped object in a boundary region of the projection images of adjacent image projection means." Sekine [0007] (emphasis added). That is, in the boundary region between adjacent projected images, problems can occur that result in "streak patterns or slits" appearing on fabricated part surfaces.

103. In the section on "Means for Solving Problem" (Sekine [0008-0009]), Sekine identifies the objective as to "provide a three-dimensional shape device that does not readily form streak patterns or slits in the shaping direction on a surface of a shaped product in a boundary region of a projection region of an exposure image." Sekine [0008] (emphasis added). The shaping device is further detailed and includes a description of a

> "control means for adjusting a boundary region between the first projection image formed by projecting the first exposure image into the resin material via the first image projection means and the second projection image formed by projecting the second exposure image into the resin material via the second image projection means." Sekine [0009].

104. Subsequently, Sekine discloses the "Effect of Invention" and repeats the effect that the "shaping device does not readily form streak patterns or slits in

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the shaping direction on a surface of a shaped product in a boundary region of a projection region of an exposure image." Sekine [0010] (emphasis added).

105. By "streak patterns" or "slits," I assume that this refers to blemishes on the part surface. The concern expressed by Sekine is that these surface blemishes occur in "a boundary region" of a "projection region" of an "exposure image." The proposed solution does not disclose a filter, digital filter, or stack of filters to solve the problem of surface blemishes.

106. In the body of the Sekine patent, nine Embodiments of the three-dimensional shaping device are proposed. Embodiment 1 describes a VPP/MP machine with a 5x5 array of projectors where adjustments of the projectors to align them and manage the overlap or boundary regions between projected images are performed mechanically, not through software or computer correction. Sekine [0013-0060]. Embodiments 2 and 3 describe digital means of correcting exposure images (projected images containing part cross-section geometry). Embodiment 2 addresses position and tilt corrections (Sekine [0062-0069]), while Embodiment 3 addresses illuminance corrections in boundary regions between adjacent images Sekine [0070-0080]. Embodiment 4 (Sekine [0081-0092]) describes a means of correcting tilt issues by adjusting the shape of the "transmissive member 12" (Sekine [0081]) that serves as the bottom of the resin vat by controlling pressure of liquid (a type of mechanical adjustment). Embodiment 5 (Sekine [0093-0098])

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provides further details on how to control the shape of the "transmissive member 12." Embodiment 6 (Sekine [0099-0105]) describes digital means for adjusting irradiance in overlap regions between adjacent exposure images. Embodiment 7 (Sekine [0106-0112]) describes a calibration method for the projection optical system that involves specialized hardware. Embodiment 8 (Sekine [0113-0126]) describes another approach to control the shape of the "transmissive member 12," while Embodiment 9 (Sekine [0127-0137]) describes further enhancements of the transmissive member shape control mechanism.

107. Sekine does not suggest that embodiments be combined; in fact, some describe adjustment and correction approaches that appear to be in conflict with one another. That is, some embodiments describe alternative approaches for addressing the need for an adjustment or correction.

2. The system of the proposed combination does not disclose "adjusting properties and aligning a position of each sub-image in the array using a set of filters" (Claims 1-8, 14-15)

108. The Sekine patent never uses the term "filter," "digital filter," "mask," or "filter mask," or similar term. As will be shown, Sekine does not disclose a "stack of filters" or anything similar to the meaning of this term.

109. Of the nine numbered Embodiments, only three describe digital means of adjustment or correction (Embodiments 2, 3, and 6). All three embodiments describe adjustments or corrections to exposure images, which are projected

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images containing part cross-section geometry. In contrast, the ‘511 patent discloses irradiance normalization and gamma adjustment filters that are independent of part cross-section geometry information. Furthermore, the Sekine patent describes exposure image correction methods performed digitally, but not as a filter or mask as disclosed in the ‘511 patent. The ‘511 patent filters are applied on top of part cross-section geometry images and are designed to work together in a stack configuration (see FIG. 2A from the ‘511 patent), in contrast to Sekine where the digital means of adjustment are described in different embodiments and not intended to work together.

110. In paragraphs 241-242 of his declaration, Dr. Chen argues that Sekine discloses “adjusting properties and aligning a position of each sub-image in the array using a set of filters” However, the reasoning proposed is incorrect. As is well known in the field, when using a multiple projector system, “illuminance correction control” and “alignment control” are needed for high quality part fabrication. But the specific methods used in Sekine have important differences from those disclosed in the '511 patent. The sentence used by Dr Chen, "However, the concept is exactly the same” (Chen ¶ 241) is misleading. Although at a high level of generality, some of the digital filters disclosed in the ‘511 patent have the same objectives as Sekine’s methods of “illuminance correction control” and “alignment control,” their methods and technologies are very different. As stated,

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the concepts of "illuminance correction control" and "alignment control" are well known in the field. What is important, however, is the methods and technologies disclosed to perform these elements of control. The '511 patent discloses digital filters to perform these corrections, while the Sekine patent describes them in different embodiments and discusses corrections made to exposure images that contain part cross-section geometry. The '511 patent filters do not contain part cross-section geometry and they are intended to work together in contrast to the correction methods in Sekine which were described in separate embodiments without consideration of how they could work together.

111. In conclusion, Sekine does not disclose "adjusting properties and aligning a position of each sub-image in the array using a set of filters."

3. The system of the proposed combination does not disclose "an irradiance mask that normalizes irradiance" (Claims 1-8, 14-15)

112. The irradiance mask in the '511 patent acts to normalize irradiance across a sub-image (from one projector) or an entire composite image (from multiple projectors) as stated in multiple places in the patent. For example, the patent states: "filter applies a normalizing irradiance mask to an image (or each sub-image in a composite image) such that the image (or composite image) has a uniform irradiance range (i.e., from zero exposure to a maximum exposure limit) across the area." '511 patent, 11:26-30. Also, the irradiance mask adjusts irradiance to "create a uniform irradiance across the whole image." '511 patent,

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23:25-26.

113. Sekine does not teach an irradiance mask that normalizes irradiance. Rather, Sekine teaches a method for adjusting the brightness difference between adjacent sub-images, but does not describe a method for ensuring uniform brightness within an area (either a sub-image or a composite image).

114. The concept of irradiance normalization was illustrated in Section V.B in paragraph 59, which uses Example 1 from the '511 patent. In this example, a projector is assumed to provide a non-uniform irradiance distribution, where the upper left corner of the image has an irradiance that is 5% less than the rest of the image. A "burn filter" was imposed that allows 100% of the irradiance to pass through in the upper left corner, while allowing only 95% of the irradiance to pass through the rest of the image.

115. Sekine does not disclose any type of adjustment that provides for uniform irradiance across an entire image. Embodiment 3 of Sekine describes an approach to controlling "illuminance" (irradiance). The Embodiment 3 description starts by reminding the reader of the objective of the patent which is to eliminate "streaks" or slits at the "boundary position of the shaped product 30." Sekine [0070]. The "boundary position" refers to boundary regions of adjacent projected images. Then, the objective of Embodiment 3 is described, which is to "eliminate the brightness difference between adjacent projection images" Sekine [0070].

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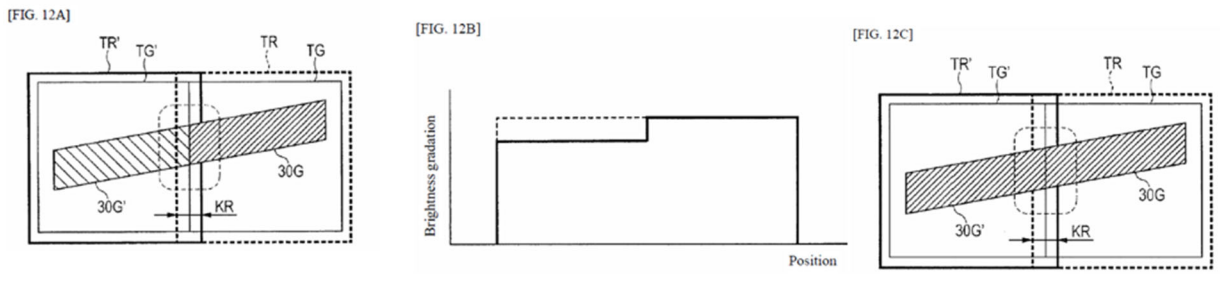
116. The next paragraph [0071] elaborates on the objective in Embodiment 3. This paragraph begins by establishing the context in which the objective is to be understood; that is, the condition to be identified is described that indicates the solution proposed by Embodiment 3. This condition is "an illuminance difference between images at the boundary of adjacent projection images TG" (emphasis added). Again, Sekine identifies that the boundaries of adjacent projection images are the subject of illumination control. This is further emphasized in the last sentence of [0071]: "to ensure that the illuminance difference between adjacent projection images TG across the boundary is eliminated," then the method of Embodiment 3 should be applied.

117. Paragraphs [0073-0080] describe the proposed methods by which the Embodiment 3 objective is to be achieved. FIG. 11 shows a flowchart of the proposed correction method and FIG. 12A-12C illustrate an example of the method applied to two adjacent exposure images of a part cross-section, 30G in the right exposure image and 30G' in the left.



118. In this method, a POSITA would understand that Sekine is concerned

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about the boundary region between adjacent images. These boundary regions are identified as item KR in FIG 12a and 12c. Specifically, “the portion located in the boundary region KR of the product projection image spanning two projection images is detected, and the illuminance correction amount of the two projection images is determined (S44).” Sekine [0075]. FIG. 12B illustrates the illuminance correction step “when there is an illuminance difference between product projection images 30G and 30G’” Sekine [0076]. As shown in FIG. 12B, the irradiance of image 30G (right) is larger than for image 30G’ (left) as shown by the thick solid lines. The difference in irradiance indicates the correction that is to be made. Specifically, the irradiance of the left image 30G’ should be increased to that of 30G; that is, “the illuminance difference of the product projection images 30G and 30G' is corrected as indicated by the dashed line.” Sekine [0076]. Notably the width of the correction is not defined in FIG. 12B. It is not clear if the total width shown along the Position axis spans the boundary region KR or the entire width of the two projected images, TG+TG’, although all the text in paragraphs [0073]-[0077] refers to the boundary region KR. With respect to the challenged claims, it does not matter if the width along the Position axis spans KR or the total width TG+TG’. The proposed method, as will be shown shortly, does not correspond to an irradiance normalization filter.

119. Importantly, paragraph [0077] describes how the illuminance

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correction amount is determined. “The CPU 111 extracts the portions located in the boundary region KR of the product projection images 30G and 30G' of adjacent projection images TG and TG'. Then, the average illuminance of the product projection image 30G in this portion is compared to the average illuminance of the product projection image 30G' to determine the illuminance correction amount.” Sekine [0077] (emphasis added). Again, Sekine focuses only on the boundary region KR. To correct the illuminance difference in the boundary region, Sekine discloses that the average illuminance in one product projection image (e.g., 30G) should be compared to the average illuminance in the boundary region of the other product projection image (e.g., 30G’). Sekine then states that the lower average illuminance should be increased to the higher value as illustrated in FIG 12B. Sekine [0076].

120. The method of Sekine can be illustrated with an example and compared to the digital irradiance normalization filter of the ‘511 patent.

121. The example from Section V.B in paragraph 59 will be used. Assume that two projectors are side-by-side and each produce projected images with the irradiance distribution shown in Illustration 4a (note the grayscale colormap has been adjusted to accentuate shading differences for the purpose of visualization). For the purposes of this example, the projector irradiances can be used, instead of exposure images with part cross-sections (e.g., 30G and 30G’), so that Sekine’s

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method can be compared to irradiance normalization filters from the ‘511 patent. Then, the instructions from Sekine will be used to construct the exposure images that implement the Sekine illuminance correction. Those exposure images will be compared to those produced using the ‘511 patent’s irradiance normalization filters. From this comparison, it will become clear that the method of Sekine does not normalize irradiance.

122. Without limitation, the sizes of the projected images will be assumed as 100x100 pixels. This yields a total projected image that is 100 pixels high and 200 pixels wide. Further, the boundary region KR is 20 pixels wide and is divided equally between the two projected images (10 pixels wide in each). The projector irradiance distributions for these two projectors are shown in Illustration 4a, along with the boundary region shown approximately as the red dashed boxes. Irradiance values are indicated at the corners of the images.

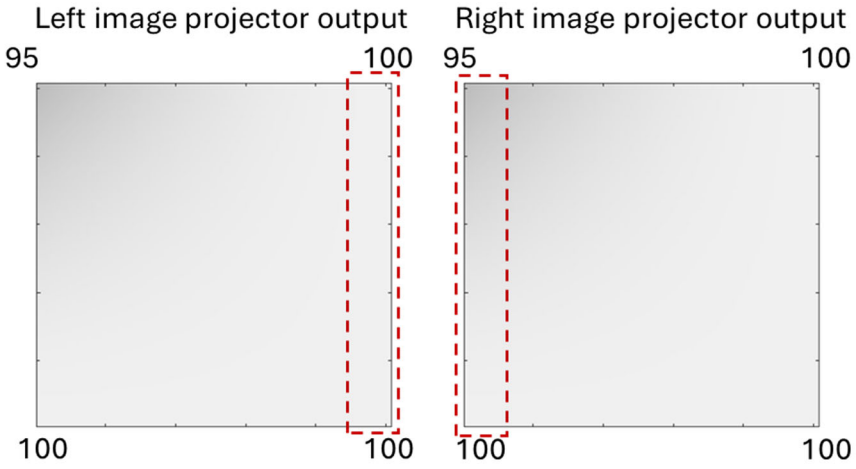

Illustration 4a: original left and right projected images

123. Following the instructions for Sekine's method, the average irradiance is computed in the boundary region for both the left image and the right image. These average irradiance values are 100 units for the left image and 98.78 units for the right image. According to the method illustrated by FIG. 12B in Sekine, the difference between these irradiance values is used to correct the image with the lower average irradiance which, in this case is the right image. The difference is 100-98.78 = 1.22 units which Sekine refers to as the "illuminance correction amount." So, the irradiance for the right image should be increased by 1.22 units. Analogous to FIG. 12B in Sekine, the irradiance correction step for this example is shown in Illustration 4b, where brightness is the Y-axis and the position along the projected images is along the X-axis. The brightness vs. position graph shows that the brightness (irradiance) of the left projector (100 units) is greater than the brightness of the right projector (98.78 units) where the difference between the two is the correction that is applied to the right projector.

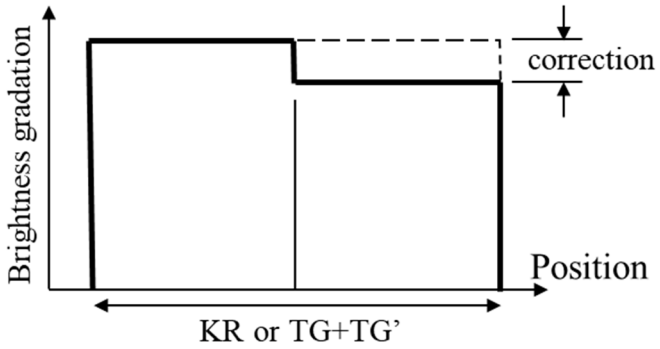

Illustration 4b: 1.22 unit correction to be applied to right image

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124. If it is assumed for the example purposes that the width of the region to be corrected is only the boundary region KR, then the resulting projected images are shown in Illustration 4c. Note that the left image has not changed, but the boundary region of the right image is now brighter, since its irradiance was increased by 1.22 units. Differences in grayscale are clearly visible.

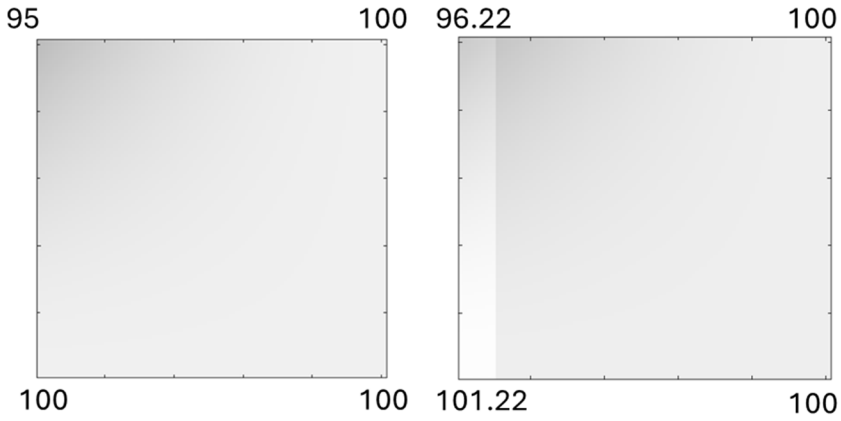

Illustration 4c: 1.22 unit correction of right image in only the boundary region

125. If the width of the correction region is taken as the span of the entire two projected images (TG+TG'), then the result is shown in Illustration 4d. Again, the left image does not change, but the entire right image increases in irradiance by 1.22 units resulting in a brighter image than previously. Again, the differences in grayscale are clearly visible.

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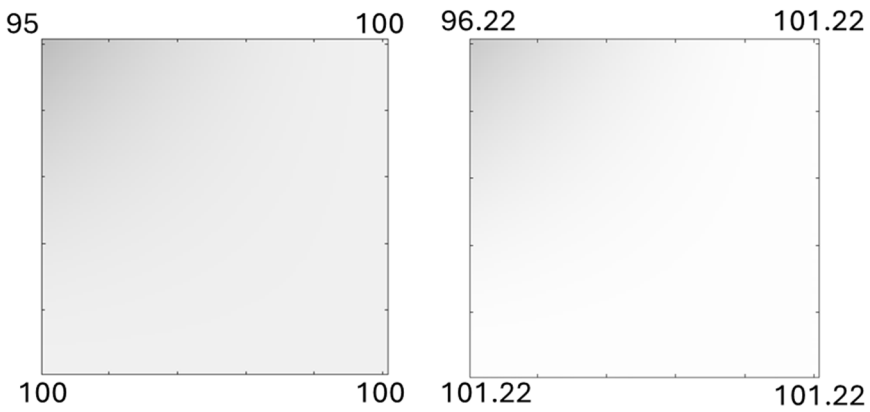

Illustration 4d: 1.22 unit correction of right image across its entire area

126. In contrast, a digital irradiance normalization filter of the ‘511 patent produces a uniform irradiance distribution. Such an irradiance normalization filter was shown in Illustration 2b as a “burn filter” that reduces the irradiance distribution in most of the projected image by 5% to match the irradiance in the upper left corner. If this irradiance normalization filter is applied to both the left and right images, then both become uniform (one uniform projected image is shown in Illustration 2c) and have the same irradiance values across their areas.

127. Similar problems arise if the irradiance distributions of the two adjacent projected images are different as the next example shows. Illustration 5a shows two adjacent projected images where the left image has a linear variation of irradiance from 60 units at the top to 100 units at the bottom, while the right image has a linear variation from 100 units to 80 units top to bottom. (irradiance variations are exaggerated to aid visual clarity in the Illustration).

128. The boundary region can be assumed to be 20 pixels wide, as in the

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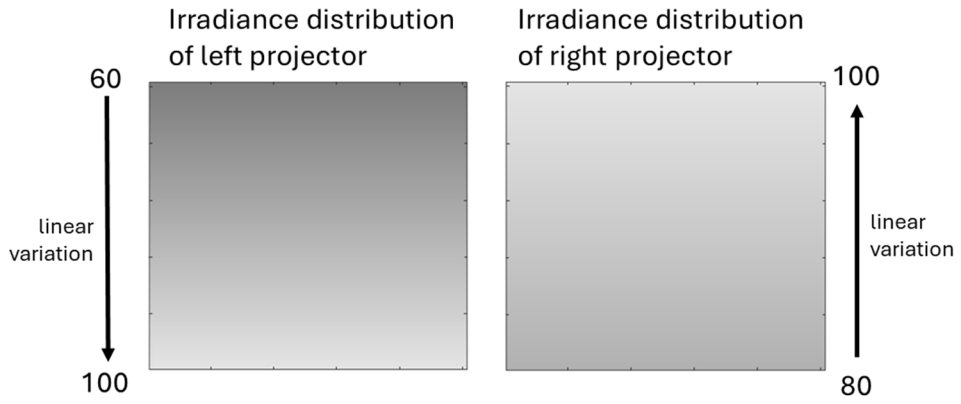
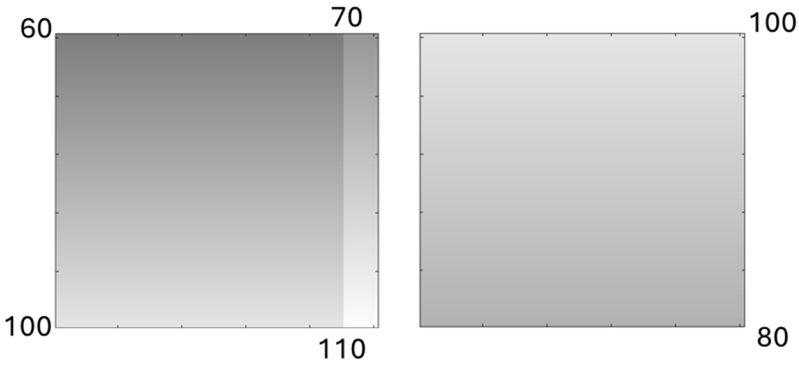
previous example. Applying Sekine's illuminance adjustment method, the average irradiance in the left image is 80 units, while the average in the right image is 90 units, giving a difference of 10 units. As such, the irradiance of the left image should be increased by this "illuminance correction amount," i.e., 10 units. Adjusting the irradiance only in the boundary region yields the irradiance distributions shown in Illustration 5b. However, if the irradiance correction is applied to the entire image, the results are shown in Illustration 5c.



a)



b)

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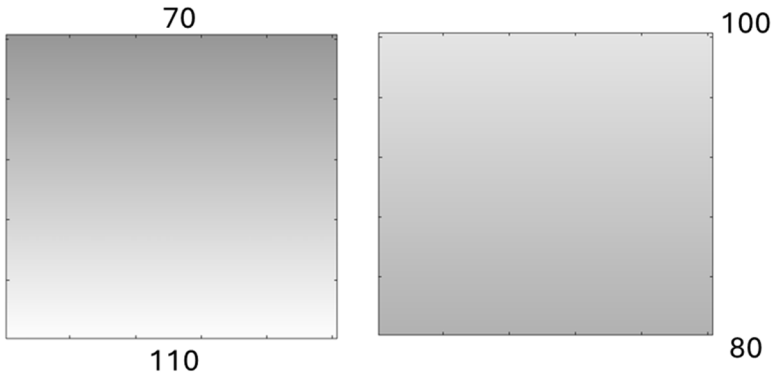

c)

Illustration 5. Application of the method of Sekine Embodiment 3 to attempt illumination correction with two projected images with linear irradiance variations. a) original left and right projected images; b) 10 unit correction of left image in only the boundary region; c) 10 unit correction of left image across its entire area

129. Again, differences in grayscale are clearly visible across both projected images, meaning that irradiance is not uniform. Further, the irradiance distribution of the left image is not the same as the irradiance distribution in the right image.

130. In Embodiment 3, Sekine also proposes that the projected image irradiance can be adjusted by changing the brightness of the light source: "it is also possible to adjust the illuminance of the entire projection image TG by changing the output of the light source 21." Sekine [0080]. The amount of the adjustment seems to be the correction disclosed in paragraph [0077] since the irradiance difference between the adjacent projected images in the boundary region was described as the correction amount ("the control unit 110 can also adjust the illuminance difference in the boundary region KR by controlling the light source 21." *id.*). However, changing the output of the light source is an operation for the

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VPP/MP machine controller. This cannot be achieved by an irradiance normalization mask.

131. On the other hand, it is possible to determine the effect of increasing light source brightness on the projected images and exposure images, regardless of the method used to change light source output. As proposed by Sekine, by increasing light source brightness, the problem identified in paragraph [0007], that of "streak patterns or slits" appearing on fabricated part surfaces, can be addressed: "By controlling the light source 21 to reduce the illuminance difference in the boundary region KR, it is possible to suppress streaks in the shaping direction (…) caused by the illuminance difference." Sekine [0080]. However, this irradiance adjustment to "reduce the illuminance difference in the boundary region KR" will produce a result that is identical to that shown in Illustrations 4d and 5c. That is, the irradiance of the entire corrected image is shifted higher by the correction factor, but this maintains the same non-uniform irradiance distribution without achieving a uniform irradiance distribution.

132. As a POSITA would understand, neither the proposed solution in paragraphs [0073-0079] nor the proposed solution in paragraph [0080] achieves the objective of irradiance normalization; that is, neither solution produces a uniform irradiance distribution. Hence, Sekine does not disclose an irradiance mask configured to normalize irradiance or an irradiance mask that normalizes

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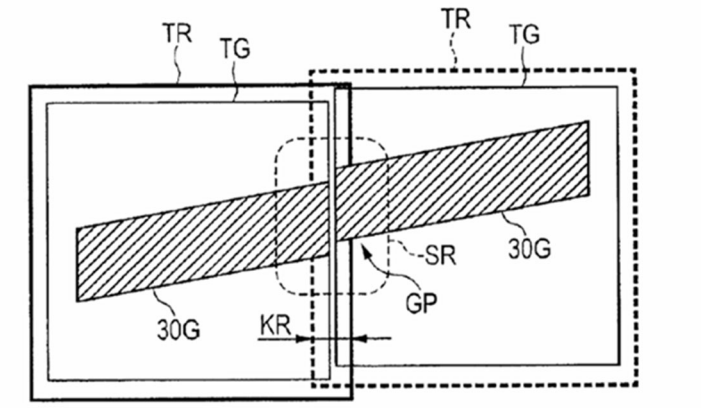
irradiance.

133. Embodiment 6 in Sekine also addresses irradiance correction, but again does not use an irradiance mask configured to normalize irradiance or an irradiance mask that normalizes irradiance as in the '511 patent. In this embodiment, the problem identified is that a gap may be formed between adjacent projected images due to an increase in the "center distance between two adjacent projection regions." Sekine [0099]. This problem is illustrated in FIG 8A from Sekine (repeated below) which shows gap GP that occurs with the boundary region KR between the projected images TG. The gap causes exposure images 30G and 30G' to separate which will cause the cured layer to have a gap. This, in turn, could cause "streak patterns or slits" (Sekine [0007]) to appear on fabricated part surfaces.

[FIG. 8A]



134. The proposed solution is a method that "deforms or adjusts the exposure image itself," to attempt to eliminate the gap between the two exposure

images 30G and 30G'. Specifically, Embodiment 6 discloses the addition of an overlap region between projected images. The solution is illustrated in FIGs. 17A-17C (repeated below). The boundary region KR is taken as the overlap extent between adjacent projected images TG1 and TG2. The projection of the part cross-section 30G is divided into a left section G1 and a right section G2. In the boundary region KR, shown as the double-cross-hatched region of 30G, the irradiance will be doubled approximately since irradiance will be received from the left projected image TG1 and the right projected image TG2. To address this double exposure, Embodiment 6 proposes to reduce the irradiance in the overlap region KR from left to right for the left projected image TG1 and to reduce the irradiance from right to left for the right projected image TG2. These irradiance reductions are described as "decreases in a stepwise manner." Sekine [0103]. In FIGs. 17B and 17C, the irradiance reductions are illustrated as being linear; i.e., straight line variations in "brightness."

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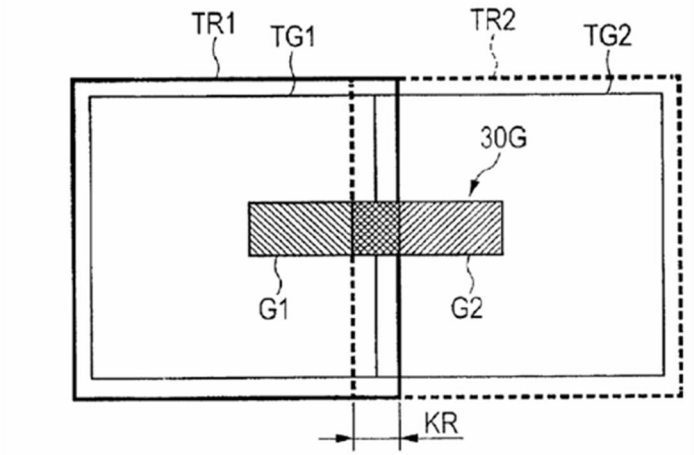
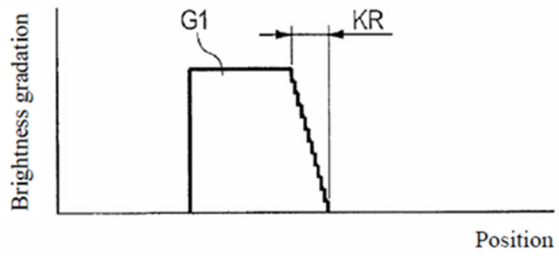
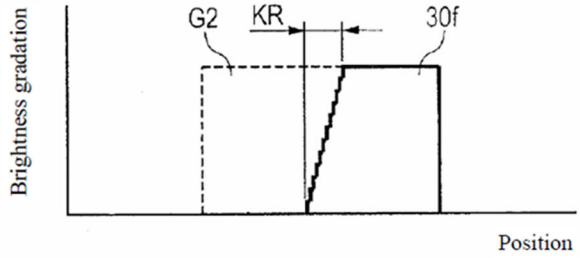
[FIG. 17A]



[FIG. 17B]



[FIG. 17C]



135. If this proposed solution is applied to the first example illustrated in Illustration 4, the result appears as in Illustration 6. Linear decreases in irradiances are applied along the right edge of the left projected image and along the left edge of the right projected image. Again, as a POSITA would understand, the results are not uniform projected images (disregarding the overlap regions); that is, the left projected image is not uniform and the right projected image is also not uniform. Further, the irradiance distributions of the left and right images are not equal. Hence, irradiance normalization has not been achieved.

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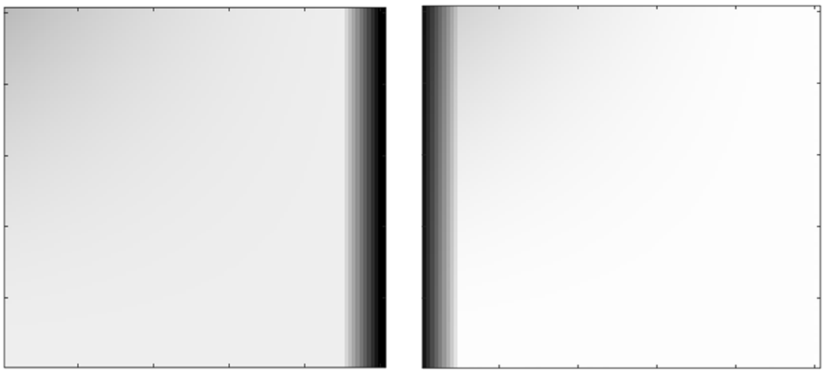

Illustration 6. "Stepwise" (linear) changes in irradiance in the overlap region on the left and right projected images applied to the projected images from Illustration 4d.

136. Since irradiance normalization has not been achieved, a POSITA would understand that Embodiment 6 does not disclose an irradiance mask configured to normalize irradiance or an irradiance mask that normalizes irradiance.

4. The system of the proposed combination does not disclose "further comprising a system controller that synchronizes exposure control of the plurality of image projectors with each other" (Claim 8)

137. The word "synchronizes" means that events happen simultaneously. In the context of exposure control with a plurality of image projectors, the meaning of the phrase "synchronizes exposure control of the plurality of image projectors with each other" means that the image projectors project images simultaneously in a coordinated manner. Furthermore, claim 8 discloses a system controller that "synchronizes exposure control," meaning that claim 8 applies to system operation when exposure control is important, which is during part fabrication.

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138. Notably, Sekine uses the word "synchronized" one time and "synchronization" three times, but never in the context of describing the control of multiple image projectors. In the first instance, "synchronized" is used in the context of using a camera to measure projection images: "The camera 130 acquires image data of the projection image TG at a sampling rate of twice the frame rate of a image forming element 27 or more, synchronized with the frame rate of the image forming element 27." Sekine [0046]. Regarding the first usage of the word "synchronization," Sekine states "The mirror of each pixel of the image forming element 23 may simply be turned ON/OFF in synchronization with switching of the exposure image RG." Sekine [0021]. This sentence describes the need to switch individual mirrors in an image generator when switching from exposure image to another. This does not disclose anything about coordinating or synchronizing a plurality of image projectors to project images at the same time (i.e., simultaneously). The second and third usages of "synchronization" appear in the "Other Embodiments" section of the Sekine patent. Both usages describe the coordination of a "lowering device 17B" Sekine [0147] or a "moving device 17C" Sekine [0148] with "switching of the exposure image in the projector 20." [0147-0148]. Again, these usages do not disclose anything about synchronizing a plurality of image projectors during part fabrication.

139. Further, Sekine uses the word "simultaneously" only one time (but not

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the word "simultaneous" or any other variation). This usage was in the context of operating a camera to capture images of an imaging area as part of the disclosed image calibration process. ("The camera 130 may be set to capture the corners of the four projection images TG simultaneously, including an imaging area (image extraction region) SR." Sekine [0142]) This does not disclose the synchronization of a plurality of image projectors during part fabrication.

140. Petitioner's argument for claiming that Sekine discloses the use of a controller to synchronize a plurality of pattern generators to simultaneously project multiple sub-images does not point to any content in the Sekine patent to support the argument:

> Sekine discusses use of multiple pattern generators simultaneously, for example "four projectors 20 [that] project the exposure image RG **divided into four to form the projection image TG** at the 67 image formation position 28." EX1005, [0043]. Sekine explicitly contemplates that a CPU may set a shaping region and "divide[] such into shaping regions of each projector 20," where the CPU further "sets the exposure images of the photocuring resin material ***for each shaping region*** of the predetermined height increment of the projectors 20." *Id.*, [0028]-[0029]. According to Sekine, the "present invention" of Sekine is provided with "first image projection means for projecting a first exposure image into the resin material from the incident surface [and] second image projection means for projecting a second exposure image **continuous with the first exposure image into the resin material from the**

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incident surface." *Id*., [0009]. It is clear to a POSITA that the invention of Sekine includes means such as a controller that controls the projection of the divided images and regions such that the corresponding areas are exposed "continuous[ly]" or simultaneously with one another. Chen ¶287.

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141. Importantly, Sekine does not discuss the "use of multiple pattern generators simultaneously," since Sekine uses the word "simultaneously" only once in the context of using a camera for image calibration.

142. Later in the paragraph quoted above, the Petitioner equates the word "continuously" with "simultaneously." This is inaccurate and misleading. The description "projecting a second exposure image **continuous with the first exposure image**" describes two exposure images that are continuous with each other in space, that is, their positions are coordinated so that they are adjacent. However, the term "simultaneous[ly]" is a synonym for synchronization which refers to events or actions taking place at the same time. In this context, the terms "continuously" and "simultaneously" have very different meanings and cannot be equated as the Petitioner has attempted to do.

143. Hence, Sekine does not disclose a "system controller that synchronizes exposure control of the plurality of image projectors with each other."

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C. Ground 3 Fails

144. In Ground 3. Petitioner contends that claims 1-8 and 14-15 of the ’511 Patent are obvious in view of Shkolnik together with Sekine. As Shkolnik was the sole reference for Ground 1 and Sekine was the primary reference for Ground 2, Ground 3 accordingly fails for the same reasons that Grounds 1 and 2 fail.

D. Ground 4 Fails

145. In Ground 4. Petitioner contends that claims 9-12 of the ’511 Patent are obvious in view of Sekine together with Greene and further with European Patent Application Publication No. EP 3,053,729 A1, “Method for exposing a photo polymerizable material for solidification of material layer by layer to build a 3D object” (“Jorgensen”).

146. Claims 9-12 are dependent claims of independent claim 1. Because Ground 2 fails with respect to independent claim 1, Ground 4 also fails for the same reasons that Ground 2 fails.

E. Ground 5 Fails

147. In Ground 5. Petitioner contends that claim 13 of the ’511 Patent is obvious in view of Sekine together with Greene, Jorgensen, and further with Yi et al., “Delta DLP 3-D Printing of Large Models,” *IEEE Transactions on Automation Science and Engineering*, Vol. 15, No. 3 (DOI: 10.1109/TASE.2017.2751664) (“Yi”).

148. Claim 13 is a dependent claim of claim 9, which is a dependent claim

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of independent claim 1. Because Ground 4 fails with respect to dependent claim 9, and because Ground 2 fails with respect to independent claim 1, Ground 5 also fails for the same reasons that Grounds 2 and 4 fail.

VII. CONCLUSION

149. This declaration reflects my opinions as currently held. However, my analysis may continue such that I may consider additional information that may result in additional observations.

150. I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true and that such statements are made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both.

Date: March 19, 2026

David Rosen, Ph.D.

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David W. Rosen
Principal Scientist
Agency for Science, Technology and Research, Singapore

I. EARNED DEGREES

Degree	Year	University	Field
Ph.D.	1992	University of Massachusetts	Mechanical Engineering
M.S.	1987	University of Minnesota	Mechanical Engineering
B.ME.	1985	University of Minnesota	Mechanical Engineering

II. EMPLOYMENT HISTORY

Title	Organization	Years
Principal Scientist	Institute of High Performance Computing & Singapore Institute of Manufacturing Technology, A*STAR, Singapore	2022-present
Adjunct Professor	Engineering Product Development Pillar, Singapore University of Technology and Design	2023-present
Research Director for DManD Center	Engineering Product Development Pillar, Singapore University of Technology and Design	2018-2022
Professor & Research Director for DManD Center	Engineering Product Development Pillar, Singapore University of Technology and Design	2016-2018
Visiting Professor	School of Mechanical and Aerospace Engineering Nanyang Technological University, Singapore	2015 - 2016
Associate Chair for Administration	George W. Woodruff School of Mechanical Engineering Georgia Institute of Technology, Atlanta, GA.	2009 - 2016
Associate Chair for Graduate Studies	George W. Woodruff School of Mechanical Engineering Georgia Institute of Technology, Atlanta, GA.	2007 – 2009
Visiting Professor	Dept. of Mechanical and Manufacturing Engr., Loughborough University, Loughborough, UK	2005 - 2011
Professor	George W. Woodruff School of Mechanical Engineering Georgia Institute of Technology, Atlanta, GA.	2004 – 2022
Associate Professor	George W. Woodruff School of Mechanical Engineering	1998-2004
Assistant Professor	George W. Woodruff School of Mechanical Engineering	1992-1998
Instructor	George W. Woodruff School of Mechanical Engineering	Summer 1992.
Research Assistant	Mechanical Design Automation Laboratory, Dept. Mechanical Engineering, University of Massachusetts, Amherst, MA.	1989 – 1992
Visiting Research Scientist	Ford Scientific Research Laboratory, Ford Motor Co., Dearborn, MI.	1990
Software Engineer	Computervision and Prime Computer, Bedford, MA.	1987 – 1989
Research and Teaching Assistant	Department of Mechanical Engineering, University of Minnesota, Minneapolis, MN.	1984 – 1987
Programmer	Control Data Corporation, St. Paul, MN.	1986
Programmer	Department of Mechanical Engineering, University of Minnesota, Minneapolis, MN.	1984
Intern Engineer	General Resource Corporation, Hopkins, MN.	1981 – 1983

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III. HONORS AND AWARDS

A. International or National Awards

1. Best Paper Award in the Artificial Intelligence and Expert Systems section at the ASME Computers in Engineering Conference for paper #8 in Conference Presentations with Proceedings, August 1992.
2. Distinguished Paper Award in ASME Design Theory and Methodology Conference for paper #26 in section IV.B (Refereed Conference Proceedings), August 1996.
3. Engineer of the Year in Education, Society of Professional Engineers, Metro Atlanta Section, 1997.
4. Highly Commended Award (awarded by the Literati Club of MCB Press) for paper IV.B.1.15, published in the Rapid Prototyping Journal, 1999.
5. Fellow, American Society of Mechanical Engineers, 2003.
6. 2nd Runner Up, Excellence Award, 3D Systems North American User Group Conference, Destin, FL, March 24-27, 2003.
7. 2nd Runner Up, Stereolithography Excellence Award, 3D Systems North American User Group Conference, Anaheim, CA, April 26-29, 2004.
8. 1st Runner Up, Stereolithography Excellence Award, 3D Systems North American User Group Conference, Tucson, AZ, April 3-8, 2005.
9. Outstanding Paper Award, Solid Freeform Fabrication Symposium, 2005 (for IV.B.2.78).
10. Best Paper Award, ASME CIE Conference, 2005 (for IV.B.2.85).
11. 1st Runner Up, Stereolithography Excellence Award, 3D Systems North American User Group Conference, Tucson, AZ, April 30 – May 4, 2006.
12. Best Presentation Award, Solid Freeform Fabrication Symposium, Austin, TX, Aug. 6-8, 2007 (for paper IV.D.66).
13. Best Paper Award, ASME Design for Manufacturing and Life Cycle Conference, 2008. Authors: C.B. Williams, F. Mistree, D.W. Rosen (for paper IV.B.2.102).
14. Outstanding Paper Award, Solid Freeform Fabrication Symposium, Austin, TX, Aug. 4-6, 2008 (for paper IV.D.69).
15. First Place, Selective Laser Sintering Excellence Award, 3D Systems User Group Conference, Daytona Beach, FL, March 15-19, 2009.
16. Best Paper Award, ASME Computers & Information in Engineering Conference, 2009. Authors: G.C. Graf, J. Chu, S. Engelbrecht, D.W. Rosen (for paper IV.B.2.104).
17. Outstanding Paper Award, Solid Freeform Fabrication Symposium, Austin, TX, Aug. 9-11, 2010 (for paper IV.D.81).
18. Best Paper Award, Virtual and Rapid Prototyping Conference, Leiria, Portugal, Sept 28 - Oct 1, 2011 (for paper IV.D.85).
19. Best Paper Award, Int'l Conference on MicroManufacturing, Chicago, March 12-14, 2012, (for paper IV.B.2.124).
20. ASME Computers and Information in Engineering Division Excellence in Research Award, 2012.
21. Solid Freeform Fabrication Symposium, International Freeform and Additive Manufacturing Excellence (FAME) Award, 2013.
22. Outstanding Presentation Award, Solid Freeform Fabrication Symposium, 2013 (for paper IV.B.2.137).
23. Best Paper Award, International Conference on Progress in Additive Manufacturing, Singapore, May 26-28, 2014 (for paper IV.B.2.141).

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24. Best Paper Award, ASME Computers and Information in Engineering Conference, Systems Engineering, Information, and Knowledge Management Technical Committee, Aug. 22, 2016 (for paper IV.B.2.158).
25. Best Paper Award, ASME Computers and Information in Engineering Conference, Computer-Aided Product and Process Design Technical Committee, Aug. 27, 2018 (for paper IV.B.2.167).
26. Best Paper Award, Journal of Manufacturing Systems, for paper IV.A.2.71 for the paper with the most citations during 2015-2019.
27. ASTM International Additive Manufacturing Award of Excellence in Research, Nov. 2021.
28. ASTM International, Award of Merit, Feb. 2022.
29. Best Presentation Award, Asia and Oceania, 4D Materials Design and Additive Manufacturing Conference, 2023 (paper IV.D.3.36).
30. Best Paper Award, International Conference on Design for 3D Printing, 2023 (paper IV.D.3.37)

B. Institute or School Awards

1. Best Masters Thesis Award for Matthew Bauer's Masters thesis, Georgia Tech chapter of Sigma Xi 1998.

IV. RESEARCH, SCHOLARSHIP, AND CREATIVE ACTIVITIES

Citations: >39,000 H-Index: 77
Student advisees in **bold**

A. Published Books, Book Chapters, and Edited Volumes

1. Books

1. Gibson, I, Rosen, D.W., Stucker, B., *Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing*, Springer, 2010. ISBN: 978-1-4419-1119-3.
2. Gibson, I, Rosen, D.W., Stucker, B., *Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing,* Second Edition, Springer, 2015. ISBN: 978-1-4939-2113-3.
3. Gibson, I, Rosen, D.W., Stucker, B., Khorasani, M., *Additive Manufacturing Technologies,* Third Edition, Springer, 2021. ISBN 978-3-030-56127-7

2. Refereed Book Chapters

1. **Bauer, M. D., Siddique, Z.**, and Rosen, D. W., "Virtual Prototyping In Simultaneous Product/Process Design For Disassembly." Book chapter in: Rapid Response Manufacturing: Contemporary Methodologies, Tools and Technologies, Ed. John Dong, Chapman & Hall, 1997.
2. Rosen, D.W., "Design-to-Manufacture Information Transfer in the Context of Solid Freeform Fabrication Technologies." Book chapter in: *Knowledge Intensive Computer Aided Design*, Ed. S. Finger, T Tomiyama, and M. Mantyla, Kluwer Academic Publishers, Boston, 2000.
3. Rosen, D.W. and Gibson, I., "Decision Support and System Selection for RP," Book chapter in *Software Solutions for RP*, Ed. I. Gibson, Professional Engineering Publishing, Ltd., UK, 2002.
4. **Siddique, Z.** and Rosen, D.W., "Common Platform Architecture: Identification for a Set of Similar Products," Chapter 9 in: *The Customer Centric Enterprise: Advances in Mass Customization and Personalization*, Ed. M. Tseng and F. Pillar, Springer, New York/Berlin, pp. 163-182, 2003.
5. Ebert-Uphoff, I., Gosselin, C.M., Rosen, D.W., and Laliberte, T., "Rapid Prototyping for Robotics." Book chapter in: Cutting Edge Robotics, Advanced Robotic Systems, International, 2005.
6. Allen, J.K., Bras, B., Mistree, F., Paredis, C., Rosen, D.W., "Georgia Institute of Technology: The Systems Realization Laboratory," Chap. 26 in *Design Process Improvement – A Review of Current Practice*, Clarkson, P. J.; Eckert, C. (Eds.), pp. 490-493, 2005.

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7. **Williams, C.B**., Allen, J.K., Rosen, D.W., Mistree, F., "Process Parameter Platform Design to Manage Workstation Capacity," Simpson, T. W., Siddique, Z. and Jiao, J., Eds., *Product Platform and Product Family Design: Methods and Applications*, Springer, New York, pp. 421-456, 2005.
8. **Wilson, J.** and Rosen, DW, "Design for Rapid Manufacturing under Epistemic Uncertainty," *Rapid Prototyping: Theory and Practice*, Chap. 11, eds.: Kamrani, A., Springer, pp. 271-291, 2006.
9. **Panchal, J.H., Choi, H-J.**, Allen, J.K., Rosen, D., Mistree, F., "An Adaptable Service-based Framework for Distributed Product Realization," *Collaborative Product Design and Manufacturing Methodologies and Applications*, Eds. W.D. Li, S.K. Ong, A.Y.C. Nee, C.A. McMahon, Springer-Verlag, pp. 1-37, 2007.
10. **Sager, B.**, Rosen, D.W., "Simulation Methods for Stereolithography," chapter 8 in: *Stereolithography: Materials, Processes and Applications*, ed. P. Bartolo, Springer, 2010.
11. **Wu, D.**, Rosen, D.W., Schaefer, D., "Cloud-Based Design and Manufacturing: Status and Promise," Chapter 1 in Cloud-Based Design and Manufacturing, ed. D. Schaefer, Springer, 2014.
12. [3] Rosen, D.W., Foundation for Intelligent Additive Manufacturing Machine Tools, 2019 Intelligent Manufacturing Report, pp. 71-81, International Coalition of Intelligent Manufacturing, 2019.
13. Hopkinson, N., Rosen, D.W., "Modeling for Polymer AM Processes," *ASM Handbook Volume 24A: Additive Manufacturing Processes*, D.L. Bourell, W. Frazier, H. Kuhn, and M. Seifi, editors, 2020.
14. Rosen, D.W., Kim, S., "Design and Manufacturing Implications of AM," *ASM Handbook Volume 24A: Additive Manufacturing Processes*, D.L. Bourell, W. Frazier, H. Kuhn, and M. Seifi, editors, 2020. doi: 10.31399/asm.hb.v24.a0006560
15. Rosen, D.W., Wong, J., "Introduction to Design for AM," *ASM Handbook Volume 24A: Additive Manufacturing Design and Applications*, D.L. Bourell, W. Frazier, H. Kuhn, and M. Seifi, editors, pp. 83-96, 2023. https://doi.org/10.31399/asm.hb.v24A.a0006947
16. Pei, E., Rosen, D.W., Seepersad, C.C., "Design Rules," *ASM Handbook Volume 24A: Additive Manufacturing Design and Applications*, D.L. Bourell, W. Frazier, H. Kuhn, and M. Seifi, editors, pp. 97-115, 2023. https://doi.org/10.31399/asm.hb.v24A.a0006948
17. Rosen, D.W., Choi, Y.M., "Intelligent Additive Manufacturing Process Chain Systems: Concepts, Implementations, and Human-Machine Interaction," 2022 Intelligent Manufacturing Report, International Coalition of Intelligent Manufacturing, 2022.
18. Rosen, D.W., Yang, J., "Design for 4D Printing," *Handbook of 4D Printing of Shape Memory Polymers*, Eds. E. Pei, G., Scalet, submitted December 2025.

3. Edited Volumes

1. Michopoulos, J., Paredis, C.C., Rosen, D.W., Vance, J., Editors, Advances in Computers and Information in Engineering Research, ASME Press, 2014. ISBN-13: 978-0791860328
2. Michopoulos, J., Paredis, C.C., Rosen, D.W., Vance, J., Editors, Advances in Computers and Information in Engineering Research, Volume 2, ASME Press, 2021. ISBN: 9780791862025

B. Refereed Publications and Submitted Articles

1. Published and Accepted Journal Articles

1. Rosen, D. W., Riley, D. R., and Erdman, A. G., "A Knowledge-Based Dwell Mechanism Assistant Designer," *ASME Journal of Mechanical Design*, vol. 113, no. 3, pp. 205-212, 1991.
2. Rosen, D. W. and Grosse, I., "A Feature-Based Shape Optimization Technique for the Configuration and Parametric Design of Flat Plates," *Engineering with Computers*, vol. 8, pp. 81-91, 1992.

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3. Rosen, D. W. and Dixon, J. R., "Languages for Feature-Based Design and Manufacturability Evaluations," *International Journal of Systems Automation: Research and Applications,* vol. 2, no. 4, pp. 353-373, 1992.
4. Rosen, D. W. and Peters, T. J., "Topological Properties that Model Feature-Based Representation Conversions within Concurrent Engineering," *Research in Engineering Design*, vol. 4, no. 3, pp. 147-158, 1992.
5. Rosen, D. W., "Feature-Based Design: Four Hypotheses for Future CAD Systems," *Research in Engineering Design*, vol. 5, no. 3, pp. 125-138, 1993. Also a conference publication: IV.B.11.
6. Rosen, D. W., Dixon, J. R., and Finger, S., "Conversions of Feature-Based Design Representations using Graph Grammar Parsing," *ASME Journal of Mechanical Design*, 116(3), pp. 785-792, 1994. Also a conference publication: IV.B.9.
7. Peters, T. J., Rosen, D. W., and Dorney, S. M., "The Diversity of Topological Applications within Computer-Aided Geometric Design," Annals of the New York Academy of Sciences, Papers on General Topology and Applications, (eds.) Andima, S. et al, Vol. 728, pp. 198-209, 1994.
8. Peters, T. J., Rosen, D. W., and Shapiro, V., "A Topological Model of Limitations in Design for Manufacturing," *Research in Engineering Design*. Vol. 6, No. 4, pp. 223-233, 1994.
9. Rosen, D. W., Bras, B. A., **Hassenzahl, S. L., Newcomb, P. J., Yu, T.**, "Towards Computer-Aided Configuration Design for the Life Cycle," *J. of Intelligent Manufacturing*. Vol. 7, pp. 145-60, 1996.
10. Rosen, D. W. and Peters, T. J., "The Role of Topology in Engineering Design Research," *Research in Engineering Design*, Vol 8, No. 2. pp. 81-98, 1996.
11. **Coulter, S. L.**, Bras, B., and Rosen, D. W., "Formulating and Solving Parametric Design Problems involving Non-Interference Constraints," *Engineering with Computers*, Vol. 13, pp. 112-24, 1997. Also a conference publication: IV.B.21.
12. Koenig, P C, Duffey, M R, Rosen, D W, Singh, P, "Design Infrastructure in Shipbuilding and Other Heavy Industries," *Transactions of the Society of Naval Architects and Marine Engineers*. Vol. 104, pp. 191-217, 1997. Also a conference publication: IV.B.29.
13. **Siddique, Z**, Rosen, D W, "Automated Product Disassembly Reasoning," *Computer-Aided Design*, vol. 29, no. 12, pp. 847-860, 1997.
14. Simpson, T.W., Rosen, D W, Allen, J K, Mistree, F, "Metrics for Assessing Design Freedom and Information Certainty in the Early Stages of Design," *ASME Journal of Mechanical Design*, Vol. 120, pp. 628 – 635, December 1998. Also a conference publication: IV.B.28.
15. **McClurkin, J. E.** and Rosen, D. W., "Computer-Aided Build Style Decision Support for Stereolithography," *Rapid Prototyping Journal*, Vol. 4, No. 1, pp. 4-13, 1998.
16. **Newcomb, P J**, Bras, B A, Rosen, D W, "Implications of Modularity on Product Design for the Life Cycle," *ASME J. of Mechanical Design*. Vol. 120, No. 3, pp. 483-90, September 1998. doi.org/10.1115/1.2829177 Also a conference publication: IV.B.26.
17. **Bauer, M. D., Siddique, Z.**, and Rosen, D. W., "A Virtual Prototyping System for Design for Assembly, Disassembly, and Service," *J. of Agile Manufacturing*, Vol. 2, No. 2, pp. 119-138, 1999.
18. Han, J.-H. and Rosen, D. W., "Special Panel Session for Feature Recognition at the 1997 ASME Computers in Engineering Conference," *Computer-Aided Design*, Vol. 30, No. 13, pp. 979-981, 1998.
19. **Bauer, M. D.** and Rosen, D. W., "A Modified Pattern Search Method with Relaxed Lexicographic Minimization for Engineering Design," *Engineering Optimization*, Vol. 32, pp. 219-247, 1999.
20. **Lynn-Charney, C.M.** and Rosen, D.W., "Accuracy Models and Their Use in Stereolithography Process Planning," *Rapid Prototyping Journal*, Vol. 6, No. 2, pp. 77-86, 2000.
21. **Harper, B. D.** and Rosen, D. W., "Computer-Aided Design for Product De- & Remanufacture," *J. of Design and Manufacturing Automation*, Vol. 4, No. 1, pp. 37-46, 2001.

22. **Siddique, Z.** and Rosen, D.W., "On Discrete Design Spaces for the Configuration Design of Product Families," *Artificial Intelligence in Engineering, Design, Automation, and Manufacturing*, Vol. 15, pp. 1-18, 2001. https://doi.org/10.1017/S0890060401152029
23. **West, A.P., Sambu, S.**, and Rosen, D.W., "A Process Planning Method for Improving Build Performance in Stereolithography," *Computer-Aided Design*, Vol. 33, No. 1, pp. 65-80, 2001.
24. Dutta, D., Prinz, F.B., Rosen, D., and Weiss, L., "Layered Manufacturing: Current Status and Future Trends," *ASME Journal of Computing and Information Science in Engineering*, Vol. 1, No. 1, pp. 60-71, 2001.
25. Hemrick, J., Starr, T., and Rosen, D., "Release Behavior for Powder Injection Molding in Stereolithography Molds," *Rapid Prototyping Journal*, Vol. 7, No. 2, pp. 115 – 121, 2001.
26. Gerhard, J.F., Rosen, D., Allen, J.K., and Mistree, F., "A Distributed Product Realization Environment for Design and Manufacturing," *ASME Journal of Computing and Information Science in Engineering*, Vol. 1, No. 3, pp. 235-244, 2001.
27. **Kataria, A.** and Rosen, D.W., "Building Around Inserts: Methods for Fabricating Complex Devices in Stereolithography," *Rapid Prototyping Journal*, Vol. 7, No. 5, pp. 253-261, 2001.
28. **Chen, Y.** and Rosen, D.W., "A Region Based Method to Automated Design of Multi-Piece Molds with Application to Rapid Tooling," *ASME Journal of Computing and Information Science in Engineering*, Vol. 2, No. 2, pp. 86-97, 2002.
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180. Wong JC, Ooi CC, Chattoraj J, Lestandi L, Dong G, Kizhakkinan U, Rosen DW, Jhon MH, Dao MH, "Graph Neural Network Based Surrogate Model of Physics Simulations for Geometry Design," IEEE Symposium Series on Computational Intelligence, Singapore, Dec 4-7, 2022.

181. Choi, C.Y, Rosen, D.W., "Exploring Generative Design for Assistive Devices," Cambridge Workshop on Universal Access and Assistive Technology, Cambridge, UK, March 27-29, 2023.

182. Rosen, D.W., Choi, C.Y., "A Design Framework for Cyber-Physical-Human-Systems," 30th ISTE International Conference on Transdisciplinary Engineering, Hua Hin, Thailand, July 11-14, 2023.

183. Rosen, D.W., Choi, C.Y., Sinha, A.K., "Toward A Design Methodology for Configuring Assistive Wearables," DESIGN Conference, Dubrovnik, Croatia, May 20-23, 2024.

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184. Sinha, A.K., Choi, C.Y., Rosen, D.W., "Automated Usability and User Experience Assessment for Smart Products and Assistive Devices," 31th ISTE International Conference on Transdisciplinary Engineering, London, UK, July 9-11, 2024.

185. Rosen, D.W., Choi, C.Y., "Toward a Configuration Design Method for Mechanical Metamaterials," Asia Design and Innovation Conference, Dec. 5-6, 2024, Shanghai, China.

186. Yan, X., Wang, Z., Rosen, D.W., Melkote, S.N., "Learning Precedence Relations for Manufacturing Operations Sequencing using Convolutional Recurrent Neural Networks," 53rd SME North American Manufacturing Research Conference, Greenville, SC, June 23-27, 2025.

187. Park, S.U., Rosen, D.W., Melkote, S.N., "Deep learning-based Multi-level retrieval of Assembly CAD models," ASME International Design Engineering Technical Conferences, paper DETC2025-156645, Anaheim, CA, August 17-20, 2025.

188. Silva, A., Kang, J., Tan, M., Rosen, D.W., "A Master Program in Sustainable Product Design: An Engineering Approach," 27th International Conference on Engineering and Product Design Education, Malta, Sept. 8-10, 2025.

189. Mi, Y., Rosen, D.W., "Immersed Isogeometric Analysis with Incremental Potential Contact," International Conference on Isogeometric Analysis (IGA 2025), Eindhoven, The Netherlands, Sept 14-17, 2025.

3. Other Refereed Materials

no data

4. Submitted Journal Articles

1. Xian, Y., Paulino, G.P., Rosen, D.W., "Integration of local accessibility constraints into topology optimization," *Int'l J. Numerical Methods in Engineering*, submitted May 2025.
2. Wang, Z.P., Meng, Z., Tian, Z., Xia, G., Wu, Z., Rosen, D.W., "Robust Shape Design Optimization of Tetra-Chiral Auxetics Using Isogeometric Analysis," *Composite Structures*, submitted September 2025.
3. Li, X, Wang, Z.P., Mi, Y., Rosen, D.W., Wang, Y., "Automated adaptive resolution framework with self-adjusting barrier regularization for stable nonlinear isogeometric topology optimization," *Structural and Multidisciplinary Optimization*, submitted Sept. 2025.
4. Quan, W., Rosen, D.W., Song, B., "A Review of Generative Artificial Intelligence for Additive Manufacturing: Bridging Design, Process Monitoring, and Beyond," *Journal of Manufacturing Systems*, submitted Dec 2025.
5. Ding, W., Wang, D., Liao, H., Rosen, D.W., Tao, R., "Manufacturability aware fiber path optimization for advanced composite shell structures," *Thin-Walled Structures*, submitted Dec 2025.
6. Mi, Y., Xing, Z., Li, X., Wang, Z.P., Rosen, D.W., Wang, Y., "A proxy-mesh method for distortion-free isogeometric topology optimization of nonlinear hyperelastic shells," *Thin-Walled Structures*, submitted Feb. 2026.

C. Other Publications and Creative Products

1. Non-refereed Conference Presentations with Proceedings

1. Bras, B. and Rosen, D., "Computer-Aided Design for De- & Remanufacturing," NSF Design and Manufacturing Grantees Conference, Albuquerque, pp. 19-20, Jan. 2-5, 1996.
2. Bras, B., Goel, A., Mistree, F. and Rosen, D., "Virtual Design, Service, and Demanufacture Studio," NSF Design and Manufacturing Grantees Conference, Albuquerque, pp. 21-22, Jan. 2-5, 1996.
3. Bras, B. and Rosen, D., "Computer-Aided Design for De- & Remanufacturing," NSF Design and Manufacturing Grantees Conference, Seattle, pp. 47-48, Jan. 7-10, 1997.

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5. **McClurkin, J.** and Rosen, D. W., "A Build Style Selection Method for Stereolithography," Proceedings North American Stereolithography User Group Conference, Orlando, February 16-20, 1997.
6. Graver, T., Rosen, D.W., McGinnis, L., "Engaging Industry in Lab-Based Manufacturing Education," ASEE Annual Conference, June 1997.
7. Clark, D. D., Mistree, F., Rosen, D.W. and Allen, J.K., "Function-Behavior-Structure: A Model for Decision-Based Design," American Society of Engineering Education, Paper No: 162501, Milwaukee, WI, June 15-18, 1997.
8. **McClurkin, J.** and Rosen, D. W., "Build Style Decision Support for Stereolithography," Proceedings Solid Freeform Fabrication Symposium, Austin, TX, pp. 627-34, August 11-13, 1997.
9. Beisher, E., Goel, A., and Rosen, D. W., "Product and Plan Models for Adaptive Disassembly Planning," Symposium on Methodologies of Intelligent Systems (ISMIS'97), Charlotte, North Carolina, October 15-18, 1997.
10. Allen, J. K. and Rosen, D. W., "Design Methodology Issues in a Distributed Studio for Rapid Tooling and Molded Parts," CIRP International Design Seminar Proceedings: Multimedia Technologies for Collaborative Design and Manufacturing, Los Angeles, pp. 21-28, October, 8-10, 1997.
11. Graver, T. W. and Rosen, D. W, "Solving the Key Problems of Making Rapid Tools," Proc. of Autofact 97, Detroit, November 3-6, 1997.
12. Rosen, D. W., Allen, J. K., Colton, J. S., Kurfess, T. R., Mistree, F., Starr, T. L., Fujimoto, R. M., and Schwan, K., "A Rapid Tooling TestBed for Injection Molding," NSF Design and Manufacturing Grantees Conference, Monterrey, Mexico, Jan. 5-8, 1998.
13. Allen, J., **Escoe, K.**, Herrmann, A., **Jangha, S., Lynn, C.**, Maier-Speredelozzi, V., Rosen, D., **West, A.**, and Xiao, A., "Automation of Design for Manufacturing Events to Improve the Product Realization Process," 7th AIAA/USAF/NASA/ISSMO Symposium on Multidisciplinary Analysis and Optimization, September 2-4, 1998.
14. **Lynn, C. M., West, A.**, and Rosen, D., "A Process Planning Method and Data Format for Achieving Tolerances in Stereolithography," Proceedings Solid Freeform Fabrication Symposium, Austin, TX, pp. August 10-12, 1998.
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18. **Lynn, C.M.** and Rosen, D.W., "SLA-250 Parts vs. Geometric Tolerances: Quantitative Results," 1999 North American Stereolithography User Group Conference, Orlando, May 17-20, 1999.
19. **West, A.**, and Rosen, D., "Process Planning Based on User Preferences," Proceedings Solid Freeform Fabrication Symposium, Austin, TX, pp. 67-76, August 9-11, 1999.
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23. Rosen, D.W., "Rapid Manufacturing Enablers: Product Fabrication without Assembly," Advanced Rapid Prototyping & Manufacturing 2000 Symposium, Georgia Tech, February 7-8, 2000.
24. Xiao, A., Allen, J.K., Rosen, D., and Mistree, F., "A Method to Design Product Architecture is a Distributed Product Realization Environment," Proceedings of the IEEE 9th International Workshop on Enabling Technologies: Infrastructure for Collaborative Enterprises (WET ICE-2000), National Institute of Standards and Technology (NIST), Gaithersburg, Maryland. June 14-16, 2000.
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31. Rosen, D.W., "Achieving Distributed Design-Manufacturing Through Design Decision Interoperability," Korea/US Joint Workshop on Information Technology for Product Development, Kyungju, Korea, July 11-12, 2001.
32. Conner-Seepersad, C, Hernandez, G, Mistree, F, and Rosen, D, "A Framework for Interactive Decision-Making in Collaborative, Distributed Engineering Design," Korea/US Joint Workshop on Information Technology for Product Development, Kyungju, Korea, July 11-12, 2001.
33. **Siddique, Z.** and Rosen, D.W., "Identifying Common Platform Architecture for a Set of Similar Products," World Congress on Mass Customization and Personalization, Hong Kong, October 1-2, 2001.
34. Tse, L.A., Seals, L., Hesketh, P.J., Gole, J. and Rosen, D.W., "Rapid prototyping of gas chromatograph with stereolithography," Fall ECS Meeting, San Francisco CA, Sept. 2001.
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40. Rosen, D.W., "Design for the Environment and Recycling," (invited talk) Japan-America Frontiers of Engineering Symposium, National Academy of Engineering, Tokyo, Japan, Oct. 24-26, 2002.
41. Panchal, J.H., Rosen, D.W., Allen, J.K., and Mistree, F. "A Computer Framework for Robust Concept Exploration in a Distributed Environment," 47th Congress of Indian Society of Theoretical and Applied Mechanics, Indian Institute of Technology, Guwahati, India December 23-26, 2002.
42. Rosen, D.W., **Nguyen, A.N., Wang, H.** "Stereolithography Skins for Digital Clay: Enabling a 3-D Deformable Computer Display," 3D Systems North American Stereolithography Users Group Conference, Destin, FL, March 24-27, 2003.
43. Rossignac, J., M. Allen, W.J. Book, A. Glezer, I. Ebert-Uphoff, C. Shaw, D. Rosen, S. Askins, J. Bai, P. Bosscher, J. Gargus, B. Kim, I. Llamas, **A. Nguyen**, G. Yuan, H. Zhu, "Finger Sculpting with Digital Clay: 3D Shape Input and Output through a Computer-Controlled Real Surface," Shape Modeling International Conference, Korea, Seoul, May 12-16, 2003.
44. **Sager, B.**, Shilling, M., Kurfess, T.R., Rosen, D.W., "Experimental Studies in Stereolithography Resolution," Proc. Solid Freeform Fabrication Symposium, Austin, TX, Aug. 4-6, 2003.
45. **Layton, A.** and Rosen, D.W., "The Effect of Layer Orientation on the Tensile Properties of Net Shape Parts Fabricated in Stereolithography," Proc. Solid Freeform Fabrication Symposium, Austin, TX, Aug. 4-6, 2003.
46. Rosen, D.W., "Process Control and Metrics," Additive/Subtractive Manufacturing Workshop, NSF, Dec. 2, 2003.
47. Rosen, D.W., "Energy and Environment," Additive/Subtractive Manufacturing Workshop, NSF, Dec. 2, 2003.
48. **Newcomb, P.J.**, Rosen, D.W., Bras, B., "Life Cycle Modularity Metrics," Proc. EcoDesign 2003, 3rd International Symposium on Environmentally Conscious Design and Inverse Manufacturing, Dec. 8-11, 2003, Tokyo, Japan.
49. Rosen, D.W., Atwood, C., Beaman, J., Bourell, D., Bergman, T., Hollister, S., "Results of WTEC Additive/Subtractive Manufacturing Study of European Research," Proc. SME Rapid Prototyping & Manufacturing Conference, paper # TP04PUB211, Dearborn, MI, May 10-13, 2004.
50. **Layton, A**, Rosen, D.W., "How to Get from Here to There in Rapid Manufacturing," Proc. SME Rapid Prototyping & Manufacturing Conference, Dearborn, MI, May 10-13, 2004.
51. Rosen, D.W., "Toward Reconfigurable Additive Manufacturing Systems," Proc. Japan-USA Symposium on Flexible Automation, paper US-002, Denver, CO, July 19-21, 2004.
52. Rosen, D.W., "Overview of the WTEC Additive/Subtractive Manufacturing Study of European Research," Proc. Solid Freeform Fabrication Symposium, Austin, TX, Aug. 2-4, 2004.
53. Rosen, D.W., "Direct Digital Manufacturing: Issues and Tools for Making Key Decisions," Proc. SME Rapid Prototyping & Manufacturing Conference, Dearborn, MI, May 9-12, 2005.
54. **Tse, A., Limaye, A.**, Rosen, D.W., "MEMS Applications of Stereolithography and Micro-Stereolithography," Proc. SME Rapid Prototyping & Manufacturing Conference, Dearborn, MI, May 9-12, 2005.
55. **Limaye, A.**, Rosen, D.W., "Compensation zone approach to avoid Z errors in Mask Projection Stereolithography builds," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 1-3, 2005.
56. **Sager, B.**, Rosen, D.W., "Development and Use of Analytical Cure Models to Improve Stereolithography Surface Finish," Proc. Int'l Conference on Advanced Research in Virtual and Rapid Prototyping Conference, Leiria, Portugal, Sept. 28-Oct 1, 2005.
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62. Rosen, D.W., **Johnston, S., Reed, M., Wang, H.**, "Synthesis Methods for Structural and Compliant Mesostructured Parts," Rapid Manufacturing Conference, Loughborough University, July 5-6, 2006.
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64. **Wang, H.V., Williams, C.**, Rosen, D.W., "Design Synthesis of Adaptive Mesoscopic Cellular Structures with Unit Truss Approach and Particle Swarm Optimization Algorithm," Solid Freeform Fabrication Symposium, Austin, TX, pp. 433-445, Aug. 14-16, 2006.
65. **Yim, S., Zhang, Y.**, Rosen, D.W., "A Repository for Design for Manufacturing Problems using Description Logics," International Conference on Manufacturing Automation, Singapore, May 28-30, 2007.
66. Rosen, D.W., "Computer-Aided Design for Additive Manufacturing of Cellular Structures," Int'l CAD Conference and Exhibition, Honolulu, June 25-29, 2007.
67. Rosen, D.W., "Design for Additive Manufacturing: A Method to Explore Unexplored Regions of the Design Space," Solid Freeform Fabrication Symposium, Austin, TX, pp. 402-415, Aug. 6-8, 2007. **Best Presentation Award**.
68. **Limaye, A.**, Rosen, D.W., "Process Planning Method to Cure Mask Projection Stereolithography Parts with Accurate Vertical Dimensions," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 6-8, 2007.
69. **Chu, C., Engelbrecht, S., Graf, G.C.**, Rosen, D.W., "A Comparison of Synthesis Methods for Cellular Structures with Application to Additive Manufacturing," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 4-6, 2008. **Outstanding Paper Award**.
70. **Engelbrecht, S**, Folgar, L, Rosen, DW, Schulberger, G, Williams, J, "Conformal Cellular Structures via SLS," 3D Stereolithography User Group Conf., Daytona Beach, FL, March 16-19, 2009.
71. **Engelbrecht, S**, Folgar, L, Rosen, DW, Schulberger, G, Williams, J, "Cellular Structure for Optimal Performance," SME Rapid Prototyping & Manufacturing Conf., Schaumburg, IL, May 12-14, 2009.
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83. Rosen, D.W., "The Georgia Institute of Technology Additive Manufacturing Research Program and Sponsor Directions," Additive Manufacturing Conference, Loughborough, UK, July 12-13, 2011.
84. **Jariwala, A.S.**, Schwerzel, R.E., Rosen, D.W., "Real-Time Interferometric Monitoring System for Exposure Controlled Projection Lithography," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 8-10, 2011.
85. **Jeong, N.**, Rosen, D.W., "A Multi-Scale Model for the Computer-Aided Design of Polymer Composites," 18th International Conference on Composite Materials, Cheju, Korea, Aug. 16-20, 2011.
86. **Zhou, W.,** Loney, D., Degertekin, F.L., Fedorov, A.G., Rosen, D.W., "Droplet Impact Dynamics in Ink-Jet Printing," Virtual and Rapid Prototyping Conference, Leiria, Portugal, Sept 28 - Oct 1, 2011. **Best Paper Award**
87. **Nguyen, J., Park, S-I**, Rosen, D.W., "Cellular Structure Design for Lightweight Components," Virtual and Rapid Prototyping Conference, Leiria, Portugal, Sept 28 - Oct 1, 2011.
88. **Jariwala, A.**, Schwerzel, R.E., Rosen, D.W., "Exposure controlled projection lithography for microlens fabrication," SPIE MOEMS-MEMS Conference, San Francisco, Jan. 21-26, 2012.
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90. **Nguyen, J., Park, S-I.**, Folgar, L., Williams, J., Rosen, D.W., "Conformal Lattice Structure Design and Fabrication," Solid Freeform Fabrication Symposium, Austin, TX., Aug. 6-8, 2012.
91. Rosen, D.W., **Jeong, N.** "Reverse Engineering of Materials using Image Processing Methods for CAD-Material Integration," Solid Freeform Fabrication Symposium, Austin, TX., Aug. 6-8, 2012.
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98. **Park, S-I.**, Rosen, D.W., Duty, C.E., "Comparing Mechanical and Geometrical Properties of Lattice Structure Fabricated using Electron Beam Melting," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 4-6, 2014.
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100. **Jeong, N.**, Rosen, D.W., "Recognizing 2D non-linear geometric features in material microstructure using 2D Cylinderlet based method," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 10-12, 2015.
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102. **Watanabe, N.**, Shofner, M., Treat, N., Rosen, D.W., "A Model for Residual Stress and Part Warpage Prediction in Material Extrusion with Application to Polypropylene Composite Materials," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 8-10, 2016.
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104. **Xian, Y.**, Rosen, D.W, "A Post-Processing Procedure for Level Set Based Topology Optimization," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 7-9, 2017.
105. **Park, SI.**, Rosen, D.W, "Estimating Strength of Lattice Structure Using Material Extrusion based on Deposition Modeling and Fracture Mechanics," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 7-9, 2017.
106. Kim, S., Rosen, D.W., "Linking Part Design to Process Planning by Design for Additive Manufacturing Ontology," Progress in Additive Manufacturing Conference, Singapore, May 14-17, 2018.
107. Xiong, Y., Duong, P.L.T., Ragavan, N., Rosen, D.W., "A Rapid Design Exploration Framework under Additive Manufacturing Process Uncertainty," Progress in Additive Manufacturing Conference, Singapore, May 14-17, 2018.
108. Park, S-I., Watanabe, N., Rosen, D.W., "Tensile Failure Prediction for Cellular Lattice Structure Fabricated by Material Extrusion using Cohesive Zone Model," Progress in Additive Manufacturing Conference, Singapore, May 14-17, 2018.
109. Rosen, D.W., "Manufacturing Elements to Support Design for Additive Manufacturing," Progress in Additive Manufacturing Conference, Singapore, May 14-17, 2018.
110. **Hume, C.**, Rosen, D.W., "Low Cost Numerical Modeling of Material Jetting-Based Additive Manufacturing," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 13-15, 2018.

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111. **Fitzharris, E.**, Rosen, D.W., Shofner, M.L., "Fast scanning differential calorimetry for semicrystalline polymers in fused deposition modeling," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 13-15, 2018.
112. **Xian, Y.**, Rosen, D.W., "Morphable Components Topology Optimization for Additive Manufacturing," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 13-15, 2018.
113. Ko, H., Witherell, P., Rosen, D., Kim, S., "A Methodology for Form Feature-oriented Modular Design Rule Representation and Ontology Development for Additive Manufacturing," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 13-15, 2018.
114. **Zhao, X.**, Rosen, D.W., "Interferometry sensing data mining for real-time geometric profile measurement in photopolymer based additive manufacturing," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 13-15, 2018.
115. Fillingim, K., Nwaeri, R.O., Fu, K., Paredis, C., Rosen, D.W., "Examining the Effect of DFAM Design Rule Presentation on Part Redesign Quality," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 13-15, 2018.
116. Weeger, O., Boddetti, G.N., Yeung, S-K., Rosen, D.W., Dunn, M.L., "Design and optimization of spatially-varying, multi-material 3D printed soft lattice structures," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 13-15, 2018.
117. Emami, M.M., Rosen, D.W., "An Improved Vat Photopolymerization Cure Model Demonstrates Photobleaching Effects," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 13-15, 2018.
118. Xiong, Y, Dharmawan, AG, Tang, Y, Soh, GS, Rosen, DW, "Computer-aided Process Planning for Wire Arc Directed Energy Deposition," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 12-14, 2019.
119. Rosen, DW, Hassani, V, Goh, E, Sarwan, S, Doetzer, F, "A Design Method to Exploit Synergies Between Fiber-Reinforced Composites and Additive Manufactured Processes," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 12-14, 2019.
120. Kim, S., Tang, Y., Rosen, D.W., "Design for additive manufacturing: Simplification of product architecture by part consolidation for the lifecycle," Solid Freeform Fabrication Symposium, Austin, TX, pp. 3-12, Aug. 12-14, 2019.
121. Tang, Y., Xiong, Y., Rosen, D.W., "A universal material template for multiscale design and modeling of additive manufacturing processes," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 12-14, 2019.
122. Emami, M., Rosen, D.W., "Process Planning for a Grayscale Frontal Photopolymerization Process," Int'l Symposium on Precision Engineering and Sustainable Manufacturing (PRESM 2021), Jeju City, South Korea, July 21-23, 2021.
123. **Xian, Y.**, Rosen, D.W., "Incorporating metal additive manufacturing-produced material properties in design by topology optimization," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 3-6, 2021.
124. Rosen, D.W., "Design for the Additive Manufacturing Process Chain," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 3-6, 2021, pp. 53-61.
125. **Mulka, N.**, Goyal, T., Jariwala, A., Rosen, D.W., "Static Liquid Interface to Reduce Support Structure Necessity in Top-Down Stereolithography," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 3-6, 2021.
126. Jayashankar, D., Devarajan, A., Dong, G., Rosen, D.W., "Design and Manufacture of Continuous Fiber-Reinforced 3D Printed Wing," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 3-6, 2021.
127. Lestandi, L, Wong, J.C., Dao, M.H., Jhon, M., Dong, G., Ford, C.S., Rosen, D.W., "Data Driven Surrogate Modelling of Part-Scale LPBF Process Simulation Using Parameterized Geometry," Mechanistic Machine Learning and Digital Twins for Computational Science, Engineering & Technology (MMLDT-CSET), San Diego, Sept. 26-29, 2021.
128. Wong, J.C., Lestandi, L, Dao, M.H., Jhon, M., Dong, G., Ford, C.S., Rosen, D.W., "Convolutional Neural Networks Modelling of Part-Scale LPBF Process for Varied Geometries in

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3D," Mechanistic Machine Learning and Digital Twins for Computational Science, Engineering & Technology (MMLDT-CSET), San Diego, Sept. 26-29, 2021.

129. **Xian, Y.**, Rosen, D.W., Paulino, G. "Incorporating Metal Additive Manufacturing-Produced Material Properties in Design by Topology Optimization," ASTM International Conference on Additive Manufacturing, Anaheim, CA, Nov. 1-5, 2021.

130. **Wang, J.**, Jariwala, A., Rosen, D.W., "Use of a Fluid Interface to Reduce Support Structures in Top-Down Stereolithography," Solid Freeform Fabrication Symposium, Austin, TX, July 25-27, 2022.

131. **Altassan, A.**, **Wong, J.**, Rosen, D.W., "Additive Manufacturing of Fiber-Reinforced Polymer Composites: A Technical Review and Status of Design Methodologies," Solid Freeform Fabrication Symposium, Austin, TX, July 25-27, 2022.

132. **Wong, J., Altassan, A.**, Rosen, D.W., "Design for Additive Manufacturing of Fiber-Reinforced Polymer Composites: Review and Status," ASTM International Conference on Additive Manufacturing, Orlando, FL, Oct 31-Nov 4, 2022.

133. Wang, D., Su, Z., Rosen, D.W., "Advanced Optimization Strategies for Innovative Stiffness-Tailored Composite Structures," Singapore Scientific Conference, Singapore, Dec. 8-11, 2025.

2. Software

no data

3. Patents

a) Patents Awarded

1. "Digital Clay Apparatus and Method," Wayne Book, Mark Allen, Imme Ebert-Uphoff, Ari Glezer, David Rosen, Jarek Rossignac. Filed: June 2002. Granted: 2004. US # 6,836,736.
2. "Digital Clay Apparatus and Method," Wayne Book, Mark Allen, Imme Ebert-Uphoff, Ari Glezer, David Rosen, Jarek Rossignac. Filed: July 2004. Granted: 2006. US # 7,047,143.
3. "Method for Making Ophthalmic Devices," Raphael Andino, Scott Meece, David Rosen, Benay Sager. Application 11/787,614. Filed Jan. 2008. Granted: Dec 2010. US # 7,860,594.
4. "Tissue Support Structure," Timothy Olsen, David Rosen, Shreyes Melkote, George Mathai. Filed March 2013. Granted: Jan 2017. US # 9,539,082.
5. "Fabricating Parts from Photopolymer Resin," Amit Jariwala, David Rosen, Fei Ding, Filed July 2011, Granted: June 2016. US # 9,367,049.

b) Provisional Patents, Applications, and Invention Disclosures

Provisional Patents and Applications

1. "Method for Making Opthalmic Devices using Single Mold Stereolithography," David Rosen, Scott Johnston, Ameya Limaye, Robert Schwerzel, Allen Gilliard. Filed: March 2008. Based on GTID: 3826 and 4140.
2. "Lattice and Cellular Structures via Additive Manufacturing and Method of Making the Same," James Williams, Luis Folgar, Gary Schlumberger, David Rosen. Filed: March 30, 2009. Based on GTID: 4656.
3. "Valveless Pump," David Rosen, David Ku, Jane Kang, Patent Application Publication US 2013/0071271A1, March 2013.
4. "Fluid Interface Supported Printing for Three-Dimensional Object Fabrication," Nicholas Mulka, Amit Jariwala, Robert Schwerzel, David Rosen. Patent Application Publication US 8774, July 2022.

Invention Disclosures

1. "Light Weight Conformal Truss Structures Manufactured Using Additive Fabrication Techniques," Hongqing Wang and David Rosen. Nov. 2000. GT ID 2388.
2. "Stereolithography and MEMS Integrated Processing," Laam Angela Tse, Peter Hesketh, David Rosen. June 2001.

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3. “Injection Mold Design Method and System for 2-Piece and Multi-Piece Molds,” Yong Chen and David Rosen, Nov. 2001. GT ID 2576.
4. “Digital Clay for Shape Input to and Display from a Computer,” Wayne Book, Mark Allen, Imme Ebert-Uphoff, Ari Glezer, David Rosen, Jarek Rossignac. May 2001. GTID: 2494.
5. “Stereolithography for Fuel Cell Fuel Delivery System,” Chi-Fu Wu, Peter Hesketh, and David Rosen, Oct. 2002.
6. “Injection Mold Design Method and System for Multi-Piece Molds with Planar Parting Planes,” Yong Chen and David Rosen, March 2003. GT ID 2856.
7. “Paper Machine Clothing Check Valves to Improve Dewatering,” David Rosen, June 2005. GTID 3513.
8. “Spinning Vat Method of Concave Lens Manufacture,” Ameya Limeya, Robert Schwerzel, David Rosen, June 2005. GTID 3529.
9. “Mask Projection Stereolithography for Customized Lenses,” Ameya Limeya, David Rosen, June 2005. GTID 3532.
10. “Smooth Stereolithography Surfaces,” Benay Sager and David Rosen, November 2005. GTID: 3680.
11. “Single Mold Stereolithography for Contact Lens Manufacture,” Scott Johnston, David Rosen, Ameya Limaye, Robert Schwerzel, April 2006. GTID: 3826.
12. “Practical Method for Single Mold Stereolithography,” Robert Schwerzel, David Rosen, March 2007. GTID: 4140.
13. “Computer-Aided Design Method for Cellular Materials,” David Rosen, Sarah Engelbrecht, February 2008. GTID: 4444.
14. “Lattice and Cellular Structures via Additive Manufacturing and Method of Making the Same,” James Williams, Luis Folgar, Gary Schlumberger, David Rosen. November 2008. GTID: 4656.
15. “Portable Renal Replacement System,” David Rosen, David Ku, Jason Weaver, Andrew Layton, Yong Yang, Jane Kang, March 2009. GTID: 4765.
16. “Process for Fabricating Plastic Microlens Arrays,” Fei Ding, Amit Jariwala, David Rosen, October 2009. GTID: 5047.
17. “Modified Tissue Support Rings/Helical Tissue Support Structure,” Timothy Olsen, David Rosen, Shreyes Melkote, George Mathai, November 2009. GTID: 4982.
18. “Pump Design for a Portable Renal Replacement System,” Jane Kang, David Ku, David Rosen, February 2010. GTID: 5161.
19. “System and Method to Fabricate Parts for Photopolymer Resin on Flat, Curved, and Inclined Surfaces,” Fei Ding, Amit Jariwala, David Rosen. May 2010. GTID: 5296.
20. “Fluid Interface Supported Printing for Three-Dimensional Object Fabrication,” Nicholas Mulka, Amit Jariwala, Robert Schwerzel, David Rosen. July 2021, GTID: 8774.
21. “A multimodal manufactured parts database creation and efficient part retrieval method,” Zhichao Wang, Xiaoliang Yan, David Rosen, Shreyes Melkote. June 2023, GTID: 9295.

4. Other Creative Products

Editorials

1. Rosen, D.W., “Design for Additive Manufacturing: Past, Present, and Future Directions,” *Journal of Mechanical Design*, Vol. 136, No. 9, 2014.
2. Rosen, D.W., Seepersad, C.C., Simpson, T.W., Williams, C.B., “Designing for Additive Manufacturing: A Paradigm Shift in Design, Fabrication, and Qualification,” *Journal of Mechanical Design*, Vol. 137, No. 9, 2015.
3. Jiang, J., Zou, B., Liu, J., Rosen, D., “Special issue on machine learning in additive manufacturing,” *International Journal of Computer Integrated Manufacturing*, 2023. DOI: 10.1080/0951192X.2023.2235679

Company Reports

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1. **Siddique, Z.**, Rosen, D. W., and Wang, N., "Investigations of Platform Commonality using Configuration Design Methods," Ford Scientific Research Laboratory Report # SR-97-168, 1997.

Project Reports

1. Bourell, D.L., Leu, M., Rosen, D.W. (2009) "Roadmap for Additive Manufacturing: Identifying the Future of Freeform Processing," final report from NSF and ONR workshop, University of Texas at Austin, April.

D. Presentations

1. Keynote Addresses and Plenary Lectures

1. **Chu, C, Graf, G**, Rosen, D.W., "Design for Additive Manufacturing of Cellular Structures," Computer-Aided Design & Applications Conference, Orlando, FL, June 23-27, 2008.
2. Rosen, D.W., "Design for Additive Manufacturing: CAD for Cellular Structures," Virtual and Rapid Prototyping (VRAP) Conference, Leiria, Portugal, Oct. 6-10, 2009.
3. Rosen, D.W., "Design Concept and Methods to Leverage Additive Manufacturing," International Conference on Manufacturing Automation, Hong Kong, Dec. 13-15, 2010.
4. Rosen, D.W., "Efficiency Advantages of Additive Manufacturing," Int'l Symposium on Green Manufacturing and Applications, Jeju, Korea, Aug. 27-29, 2012.
5. Rosen, D.W., "Information Modeling for Innovative Design and Manufacturing: Is a Mechanical Engineering Markup Language Feasible?" Int'l Conference on Innovative Design & Manufacturing, Taipei, Taiwan, Dec. 12-14, 2012.
6. Rosen, D.W., "Multi-Scale Computer-Aided Design for Additive Manufacturing," Int'l Conference on Innovative Design and Manufacturing, Montreal, Canada, Aug. 13-15, 2014.
7. Rosen, D.W., "High Viscosity Printing," NIP30/Digital Fabrication Conference, Philadelphia, Sept 7-11, 2014.
8. Rosen, D.W., "Controlling Localized Photopolymerization: Advances in Stereolithography," Int'l Conf Additive Manufacturing-Biomanufacturing, Beijing, China, Nov. 12-14, 2014.
9. Rosen, D.W., "Design for Additive Manufacturing: Leveraging the Unique Capabilities of AM," Procter & Gamble Chemistry & Materials Joint Symposium, Cincinnati, OH, Oct. 15, 2015.
10. Rosen, D.W., "Design for Additive Manufacturing: Topology Optimization," Progress in Additive Manufacturing Conference, Singapore, May 18, 2016.
11. Rosen, D.W., "Trends in Additive Manufacturing," Korean Society of Manufacturing Technology Engineers, Jeju City, South Korea, Nov. 3, 2016.
12. Rosen, D.W., "Additive Manufacturing: Processes and Trends," Asia-Korea Conference on Science & Technology, Singapore, Nov. 16-18, 2017.
13. Rosen, D.W., "Polymers in Additive Manufacturing: Survey and Opportunities," TMS Conference, Phoenix, AZ, March 11-15, 2018.
14. Rosen, D.W., "Standards Developments in Additive Manufacturing," Progress in Additive Manufacturing Conference, Singapore, May 16, 2018.
15. Rosen, D.W., "Advances in Design for Additive Manufacturing," International Conference on Engineering Innovation, Bangkok, Thailand, July 5-6, 2018.
16. Rosen, D.W., "Design for Additive Manufacturing: Opportunities and Challenges," CAD Conference, Singapore, June 24-26, 2019.
17. Rosen, D.W., "Design for Additive Manufacturing: Opportunities and Challenges," ASME IMECE Design, Systems and Complexity Track, Salt Lake City, Nov. 13, 2019.
18. Rosen, D.W., "Active Transdisciplinary Engineering Education for Competence Development in an Intelligent Manufacturing Era," International Conference on Active Learning in Engineering Education (PAEE/ALE 2020), Pathumthani, Thailand, August 26-28, 2020.
19. Rosen, D.W., "Smart Additive Manufacturing Process Chains," Int'l Symposium on Precision Engineering and Sustainable Manufacturing (PRESM 2021), Jeju City, South Korea, July 21-23, 2021.

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20. Rosen, D.W., "Design for the Additive Manufacturing Process Chain," plenary lecture at Solid Freeform Fabrication Symposium, Austin, TX, Aug. 2-4, 2021.
21. Rosen, D.W., "Can Digital Design and Manufacturing Lead to A Better World?," International Conference of Additive Manufacturing for a Better World, Singapore, Aug. 23-25, 2022.
22. Rosen, D.W., "Design Exploration and Optimization Across Additive Manufacturing Process Chains," Asian Society for Precision Engineering and Nanotechnology (ASPEN) Conference, Singapore, Nov. 15-18, 2022.
23. Rosen, D.W., "Smart Manufacturing as a Cyber-Physical-Human System," 10th Asia-Korea Conference, Singapore, Nov. 24-27, 2022.
24. Rosen, D.W., "Developing Additive Manufacturing Solutions – From Research To Development And Towards Integrated End-to-end Platform Solutions," SIMTech 30th Anniversary Conference, Singapore, July 26, 2023.
25. Rosen, D.W., "What Topics are at the Design for Additive Manufacturing Research Frontier?," International Conference on Design for 3D Printing, Jeju, South Korea, Oct. 19, 2023.
26. Rosen, D.W., "Design for Additive Manufacturing: Implications for Sustainability," International Design Conference, Dubrovnik, Croatia, May 20-23, 2024.
27. Rosen, D.W., "Technology Roadmap and Evolution of Additive Manufacturing," Research Advances in Additive Manufacturing Conference, Nanjing, China, 28-30 June, 2024.
28. Rosen, D.W., "Design for 4D Printing," 4D Materials Design and Additive Manufacturing Conference, Ajaccio, France, July 4-5, 2024.
29. Rosen, D.W., "Artificial Intelligent Manufacturing: Current Status and Future Directions," Intelligent Manufacturing Forum, Wuhan, China, 20, Oct. 2024. (600 pax)
30. Rosen, D.W., "Artificial Intelligence in Smart Manufacturing," Smart Manufacturing Workshop, University of Shanghai for Science and Technology, Dec. 7. 2024. (70 pax)
31. Rosen, D.W., "Artificial Intelligence in Additive Manufacturing," Research Advances in Additive Manufacturing Conference, Nanjing, China, 26-28 May, 2025. (300 pax)
32. Rosen, D.W., "Artificial Intelligence in Additive Manufacturing," International Institute of Welding General Assembly and International Conference, June 22-27, 2025. (80 pax)
33. Rosen, D.W., "Design for Additive Manufacturing," International Conference on Design Science, Shanghai Jiao Tong University, July 25, 2025. (140 pax)
34. Rosen, D.W., "Design for 4D Additive Manufacturing," 1st International Conference on FutureAM, Singapore, 5 Aug. 2025. (200 pax)
35. Rosen, D.W., "Artificial Intelligence in Additive Manufacturing," Solid Freeform Fabrication Symposium, Austin, TX, USA, 11-13 Aug, 2025. (250 pax)
36. Wong, J., Rosen, D.W., "Topology Optimization of Continuous Fiber-Reinforced Composites with Manufacturing Constraints," International Conference of Digital Composite Manufacturing, Jinju, South Korea, 15 Jan, 2026. (100 pax)
37. Rosen, D.W., "Artificial Intelligence in Additive Manufacturing," 16th Japan Additive Manufacturing Symposium, Tokyo, 21 Jan 2026. (70 pax)
38. Rosen, D.W., "Conceptual Design for 4D Printing," 4D Materials Design and Additive Manufacturing Conference, Dublin, Ireland, July 8-9, 2026.

2. Invited Conference and Workshop Presentations

1. Rosen, D.W., "Trusses, Tools, and Tolerances: Examples of Integrating Design and Manufacture," (invited talk) Spatial Summit, Boulder, CO, June 2-4, 2003.
2. Rosen, D.W., "Information and Knowledge Management in PLM –Some Research Opportunities," ASME Computers and Information in Engineering Conf., Panel Session on

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"From Engineering Database Management to Product Lifecycle Management," Salt Lake City, Sept 29-Oct 1, 2004.

3. Rosen, D.W., "Personalized Manufacturing," ASME Design Automation Conference, Panel Session on "Strategic Engineering," Salt Lake City, Sept 29 – Oct 1, 2004 (invited).
4. Rosen, D.W., "Design for Additive Manufacturing," ASME Computers and Information in Engineering Conf., Panel Session on "Design for X," Salt Lake City, Sept 29-Oct 1, 2004 (invited).
5. Rosen, D.W., "Additive Manufacturing of Cellular Structures," ASME Computers and Information in Engineering Conf., Panel Session on "Object Modeling and CAD for Emerging Bio/Micro/Nano Systems," Long Beach, CA, Sept 25-29, 2005 (invited).
6. Rosen, D.W., "Cellular Structures for High Stiffness, Compliance, and Other Multifunctional Applications," ASME IMECE, Panel Session on Rapid Prototyping, Orlando, Nov. 6-11, 2005.
7. Rosen, D.W., "Design for Additive Manufacturing Methods with Application to Medical Implant Development," invited talk at the Indo-US Workshop on Solid Freeform Fabrication for Tissue Engineering and Biomedical Applications, Bangalore, India, February 22-24, 2007.
8. **Yim, S., Wilson, J.O.**, Rosen, D.W., "An Ontology for Bio-Inspired Engineering Design," Ontology Workshop, KAIST, Daejon, Korea, July 8, 2008 (invited).
9. Rosen, D.W., "SSS Approach and Creativity Metrics for Bio-Inspired Design," Bio-Inspired Workshop: Charting a Course for Computer-Aided Bio-inspired Design Research, Palo Alto, CA, March 20, 2011.
10. Rosen, D.W., "Computer-Aided Design for Additive Manufacturing: Can We Exploit Shape and Material Complexity Capabilities?" Laser Based Production Processes Conference, Heriot-Watt University, June 26, 2012.
11. Rosen, D.W., "Rapid Manufacturing 101 and Roadmap," NSF Summer Institute on Nanomechanics and Nanomaterials and Micro/Nanomanufacturing, Northwestern University, May 29-31, 2013.
12. Rosen, D.W., "Design for Additive Manufacturing," NSF Summer Institute on Nanomechanics and Nanomaterials and Micro/Nanomanufacturing, Northwestern University, May 29-31, 2013.
13. Rosen, D.W., "What Should CAD be for Exploring Unexplored Design Spaces?" DARPA/ISAT Workshop on Rethinking CAD, Arlington, VA, Oct. 24, 2013.
14. Rosen, D.W., "Additive Manufacturing Education at Georgia Tech," NSF Workshop on the Educational Needs and Opportunities in Additive Manufacturing, Arlington, VA, April 10-11, 2014.
15. Rosen, D.W., "Design for Additive Manufacturing Technologies for Lightweight Structures," Raytheon Additive Manufacturing Workshop, Indianapolis, IN, June 4, 2014.
16. Rosen, D.W. and Collins, S., "ASTM International F42 Committee on Additive Manufacturing," Raytheon Additive Manufacturing Workshop, Indianapolis, IN, June 4, 2014.
17. Rosen, D.W., "Overview of Processes for Additive Manufacturing," NSF Workshop on the Environmental Implications of Additive Manufacturing, Arlington, VA, October 14-15, 2014.
18. Rosen, D.W., "Design for Additive Manufacturing," panelist at AIAA Science and Technology Forum and Exposition, session: Advanced Manufacturing and its Impact on the Design Process of the Future, Kissimmee, FL, Jan. 5-9, 2015.
19. Rosen, D.W., "Impacts of Additive Manufacturing on DFM/DFA and DFLC," Panelist at ASME Design Automation Conference, Boston, Aug. 3-5, 2015.
20. Rosen, D.W., "AM Founders and Futurists," Panelist at ASME AM3D, Boston, Aug. 3-5, 2015.
21. Rosen, D.W., "Design for Additive Manufacturing," workshop at the School of Mechanical and Aerospace Engineering, Nanyang Technological University, Singapore, May 23, 2016.

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22. Rosen, D.W., "Key Challenges Faced by Industry in Consideration of Public Comments," Workshop on Key Aspects of Good Regulatory Practice, Jakarta, Indonesia, March 16, 2017.
23. Rosen, D.W., "Standardization Efforts for Additive Manufacturing in ASTM International," 2nd Shanghai Additive Manufacturing Association International Forum, Shanghai, China, Oct. 20-22, 2017.
24. Rosen, D.W., "Trends and Opportunities in Additive Manufacturing," Panel discussion, Stratasys 3D Printing Forum, Shanghai, China, Oct. 24, 2017.
25. Rosen, D.W., Dunn, M.L., Lim, K.H., "Voxel-Based Digital Design and Manufacturing," Stratasys 3D Printing Forum, Shanghai, China, Oct. 24, 2017.
26. Rosen, D.W., "Smart Manufacturing," Panel discussion, Smart Nation in Singapore workshop, Singapore, Oct. 27, 2017.
27. Rosen, D.W., "Advanced Optimization Strategies for Additive Manufacturing," A*Star Design Workshop, Singapore, Nov. 7-9, 2017.
28. Rosen, D.W., "Impacts of 3D Printing on Industry 4.0 – and Vice Versa," Asia-Korea Conference on Science & Technology, Singapore, Nov. 16-18, 2017.
29. Rosen, D.W., "Digital Design and Manufacturing," Keppel Offshore Marine Technology & Engineering Program, Nov. 13, 2017.
30. Rosen, D.W., "4D Printing," Disruptive Innovation Summit, Singapore, Feb. 5-6, 2018.
31. Rosen, D.W., "Digital Manufacturing and Design for the Aerospace Industry," Singapore Aviation Safety Seminar, Singapore, March 26-28, 2018.
32. Rosen, D.W., "How Additive Manufacturing/3D Printing Will Upend Traditional Manufacturing," Smart Manufacturing, 3D Printing and Industry 4.0 Forum, Singapore, May 8-9, 2018.
33. Boddeti, G.N., Weeger, O., Park, S.I., Xian, Y., Dunn, M.L., Rosen, D.W., "Additive Manufacturing Opportunities: Multiscale Topology Optimization and Related Topics," International Union of Theoretical and Applied Mechanics Symposium, When Topology Optimization Meets Additive Manufacturing – Theory and Methods, Dalian, China, Oct 8-12, 2018.
34. Rosen, D.W., "Design for Additive Manufacturing," ASTM Additive Manufacturing Center of Excellence Training Workshop, Auburn, AL, March 25, 2019.
35. Rosen, D.W., "Connecting Information Technology and Operational Technology for Digital Manufacturing," 4th Annual Manufacturing Excellence, Singapore, July 30, 2019.
36. Rosen, D.W., "Design for Additive Manufacturing," Department of Mechanical Engineering, King Mongkut University of Technology North Bangkok, Bangkok, Thailand, August 3, 2019.
37. Rosen, D.W., "Additive Manufacturing Education at Georgia Tech," Materials Science & Technology, Portland, OR, Sept. 29 – Oct 3, 2019.
38. Rosen, D.W., "Multiscale design representations and a material template," Center for Additive Manufacturing Systems annual meeting, Jeju City, South Korea, Dec. 19, 2019.
39. Rosen, D.W., "Design for Additive Manufacturing," ASTM Additive Manufacturing Center of Excellence Training Workshop, El Paso, TX, Feb. 10, 2020.
40. Rosen, D.W., "Design for the Additive Manufacturing Process Chain," Baker Hughes Additive Manufacturing Symposium, May 29, 2020.
41. Rosen, D.W., "How AI and Product-Process Co-Design will change Computer-Aided Design," Defence Science Organization workshop, Singapore, August 7, 2020.
42. Rosen, D.W., "Product-Process Co-Design Optimization," Digital Manufacturing and Design Centre Symposium, Singapore, Sept 1-3, 2020.
43. Rosen, D.W., "Multi-scale Topology Optimization for Additive Manufacturing," Int'l Symposium on Precision Engineering and Sustainable Manufacturing, Seoul, South Korea, Nov 16-18, 2020.

44. Rosen, D.W., "Smart Additive Manufacturing Process Chains for Part Production and Design," ASME Manufacturing Science and Engineering Conference (MSEC), Smart Additive Manufacturing symposium, June 21-25, 2021.
45. Rosen, D.W., "DEmocratizing Manufacturing Accessibility for Designers (DEMAND): "uber" for manufacturing," workshop at Northwestern University, Aug. 3-5, 2021.
46. Rosen, D.W., "Design of Human/Social-Cyber-Physical Systems: Implications for Future Intelligent Manufacturing Systems," 2021 Annual Meeting of the International Coalition of Intelligent Manufacturing, Beijing, China, Dec. 7, 2021.
47. Rosen, D.W., "Sustainable Design for Additive Manufacturing: Opportunities and Challenges," Sustainable Design for Additive Manufacturing workshop, DESIGN Conference, on-line, May 23-26, 2022.
48. Jiang, J., Xiong, Y., Zhang, Z., Rosen, D.W., "Machine learning integrated design for additive manufacturing," INFORMS Annual Meeting, Indianapolis, October 16-19, 2022.
49. Rosen, D.W., "Smart Manufacturing as a Cyber-Physical-Human System," 2022 Annual Meeting of the International Coalition of Intelligent Manufacturing, Nanjing, China, Nov. 24, 2022.
50. Rosen, D.W., Ong, J.K., Tan, U-X., Tan, Q.Y., Kizhakkinan, U., Do, H.Q., Wong, J.C., Ford, C.S., "Convolutional Neural Networks for Additive Manufacturing Surrogate Models," 11th Int'l Conference on Materials for Advanced Technologies, Singapore, June 26-30, 2023.
51. Rosen, D.W., "Design for the Additive Manufacturing Process Chain," ASTM International Conference on Additive Manufacturing, Washington, DC, Oct 30 – Nov 3, 2023.
52. Rosen, D.W., "Design for Additive Manufacturing," International Conference on Additive Manufacturing and Bio-Manufacturing, Beijing, China, March 29-31, 2024.
53. Rosen, D.W., "Design for Additive Manufacturing Research Frontier," Advanced Technologies for Next Generation Aerospace Systems: Materials, Manufacturing, and Process Standardization, Busan, South Korea, Sept 30, 2024.
54. Rosen, D.W., "Design Optimization for Polymer Composite Additive Manufacturing," Advanced Technologies for Next Generation Aerospace Systems: Materials, Manufacturing, and Process Standardization, Busan, South Korea, Oct 1-3, 2024.
55. Rosen, D.W., "Design for 4D Printing," ASTM International Conference on Additive Manufacturing, Atlanta, GA, Oct 28 – Nov 1, 2024.
56. Wong, J., Sanders, E., Rosen, D.W., "Topology Optimization of Continuous Fiber-Reinforced Composites Considering Manufacturing Constraints," ASTM International Conference on Additive Manufacturing, Atlanta, GA, Oct 28 – Nov 1, 2024.
57. Altassan, A., Rosen, D.W., Sanders, E., "Topology Optimization of Continuous Fiber-Reinforced Polymer Composites with Spatially-Varying Fiber Volume Fraction and Bi-Modulus Material Properties," ASTM International Conference on Additive Manufacturing, Atlanta, GA, Oct 28 – Nov 1, 2024.
58. Rosen, D.W., Panelist at the ASTM Shaping the Future: Standards and Innovation in Additive Manufacturing, Singapore, January 24, 2025.
59. Rosen, D.W., "Design Principles for Additive Manufacturing," ASTM Additive Manufacturing Snapshot Workshop, Manila, Philippines, Sept. 22, 2025.
60. Liu, G., Liu, J., Wang, S., Hemond, J., Rosen, D.W., "Distortion prediction of digital light processing 3D printed vat photopolymerization components using a multiphysics modelling framework," ASTM International Conference on Additive Manufacturing, Las Vegas, NV, Oct 6-10, 2025.
61. Madan, J., Witherell, P., Rosen, D.W., "Gaps and Opportunities for the Design of Customized Additively Manufactured Medical Implants," ASTM International Conference on Additive Manufacturing, Orlando, FL, USA, Sept. 28 – Oct 2, 2026.

3. Conference and Workshop Presentations

1. Rosen, D. W., "Functions Transforming Engineering Designs into Manufactured Products," Eighth Summer Conference on General Topology and Applications, Queens College, Flushing, NY, June 18-20, 1992.
2. Peters, T J, Rosen, D. W., and Shapiro, V., "Topological Spaces for Modeling Feature Conversions from Design to Manufacturing," Third SIAM Conference on Geometric Design, Tempe, AZ, Nov. 1993.
3. Rosen, D. W. and Duffey, M., "Can DFM Methods Help Address Strategic Design Decisions?" ORSA-TIMS Conference, Detroit, October 24-26, 1994.
4. Rosen, D. W., "Strategic Design: Enabling Customized, High Value Engineered Products in Distributed Enterprises," American Economics Association Annual Conference, Atlanta, Jan 4-6, 2002.
5. Rosen, D.W., "Rapid Prototyping for Mass Customization," CASA-RPA Technology Forum on Mass Customization enabled by Rapid Technologies, Georgia Tech, August 13, 2002.
6. Rosen, D.W., "Truss Structure Design and Manufacturing for Ultra-Lightweight Stiff and Compliant Structures," SME SUMMIT Conference, Los Angeles, March 28-30, 2006.
7. Rosen, D.W., Johnston, S., Reed, M., Wang, H., "Computational Design of 3-D Mesoscopic Lattice Structures for Stiffness and Compliance," World Congress on Computational Mechanics, Los Angeles, July 16-21, 2006.
8. **Sager, B.**, Rosen, D.W., "SL Surface Finish Characterization via Development and Validation of Analytical Cure Model," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 14-16, 2006.
9. **Meacham, J.M., O'Rourke, A., Yang, Y.**, Fedorov, A.G., Degertekin, F.L., Rosen, D.W., "Printing High Viscosity Fluids using Ultrasonic Droplet Generation," Virtual and Rapid Prototyping (VRAP) Conference, Leiria, Portugal, Oct. 6-10, 2009.
10. Rosen, D.W., **Sohail, A.**, "Multifunctional Devices enabled by Additive Manufacturing," Solid Freeform Fabrication Symposium, Austin, TX., Aug. 12-14, 2013.
11. Cooke, A.L., Folgar, C.E., Folgar, L.N., Williams, J., Rosen, D.W., **Park, S-I.**, "An Investigation of the Material Properties of Laser Sintered Parts Incorporating Conformal Lattice Structure (CLS) Technology," Solid Freeform Fabrication Symposium, Austin, TX., Aug. 12-14, 2013.
12. Rosen, D.W., "The FAME Award: Looking Backward and Forward 15 Years," Solid Freeform Fabrication Symposium, Austin, TX., Aug. 12-14, 2013.
13. Rosen, D.W., "A High School Education Program in Systems Engineering and Additive Manufacturing," Workshop on Design in Engineering Education, National University of Singapore, Sept. 23, 2013.
14. Rosen, D.W., "Research on Sensors and Closed-Loop Control for Additive Manufacturing," Additive/Aerospace Pre-Summit Workshop: Standards for Advanced Additive Manufacturing Platforms, Los Angeles, Oct. 16-18, 2013.
15. **Jones, H.H.**, Jariwala, A.S., Rosen, D.W., "Fabrication Results from Real-Time Control of the Exposure Controlled Projection Lithography Process," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 406, 2014.
16. Rosen, D.W., "Issues and Challenges: Design – Then," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 4-6, 2014.
17. Rosen, D.W., "Design, CAD, and Process Modeling for Additive Metal Platforms," Additive/Aerospace Workshop: Additive Manufacturing for Aerospace 101, Los Angeles, Nov. 4-6, 2014.
18. Rosen, D.W., "AlpZhi, Inc. Start-Up Pitch," Additive Disruption Summit, Santa Clara, CA, April 1-2, 2015.

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19. **Jeong, N.**, Rosen, D.W., "Recognizing 2D non-linear geometric features in material microstructure using 2D Cylinderlet based method," Solid Freeform Fabrication Symposium, Aug. 10-12, 2015.
20. Allison, J., Sharpe, C., Rosen, D.W., Seepersad, C.C., "Direct Metal Laser Sintering of Lattice Structures," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 8-10, 2016.
21. **Hume, C.**, Rosen, D.W., "Material Jetting Feature Resolution and Scale-up for Variable Resistance Filter Fabrics," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 8-10, 2016.
22. **Park, S.I.**, Watanabe, N., Shofner, M., Treat, N., Rosen, D.W., "Estimating Strength of Material Extrusion Lattice Structures based on Interlayer Bonding Strength from Process Simulation with Thermal Analysis," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 8-10, 2016.
23. **Zhao, X.**, Rosen, D.W., "Real-Time Metrology for Photopolymer Additive Manufacturing with Exposure Controlled Projection Lithography," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 7-9, 2017.
24. Rosen, D.W., "Research in the Digital Manufacturing and Design Centre at SUTD," 2nd Shanghai Additive Manufacturing Association International Forum, Shanghai, China, Oct. 20-22, 2017.
25. **Hume, C**, Rosen, DW, "Numerical Modeling and Evaluation of Material Jetting-Based Additive Manufacturing," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 12-14, 2019.
26. Raju, N, Rosen, DW, "Study of Printing Direction, Post-Processing Effects on Mechanical and Material Properties of EOS MS1 Maraging Steel," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 12-14, 2019.
27. Park, S-I., Xiong, Y., Tang, Y., Rosen, D.W., "Development of Implicit CAD System for Multi-material Additive Manufacturing," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 12-14, 2019.
28. Emami, M.M., Rosen, D.W., "Explanatory Multiphysics Modelling of Generated Heat in Vat Photopolymerization"," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 12-14, 2019.
29. Emami, M.M., Rosen, D.W., "Explanatory Multiphysics Modelling of Generated Heat in Vat-Polymerization," International Conference on Simulation for Additive Manufacturing, Pavia, Italy, Sept. 11-13, 2019.
30. Jamshidian, M., Boddeti, N., Rosen, D.W., Weeger, O., "Large deformation response of 3D printed soft lattice structures using micromechanical finite element analysis," International Conference on Simulation for Additive Manufacturing, Pavia, Italy, Sept. 11-13, 2019.
31. Park, S-I., Tang, Y., Xiong, Y, Rosen, D.W., "Design for 4D Printing by Enabling Eigenstrains," 56th Meeting of the Society of Engineering Science, St. Louis, MO, Oct. 13-15, 2019.
32. Emami, M., Rosen, D.W., "Process Planning for a Grayscale Frontal Photopolymerization Process," Int'l Symposium on Precision Engineering and Sustainable Manufacturing (PRESM 2021), Jeju City, South Korea, July 21-23, 2021.
33. **Altassan, A., Wong, J.**, Rosen, D.W., "Design for Additive Manufacturing of Fiber-Reinforced Polymer Composites: Review and Status," ASTM International Conference on Additive Manufacturing, Orlando, FL, Oct 31-Nov 4, 2022.
34. Rosen, D.W., Ong, J.K., Tan, U-X., Tan, Q.Y., Kizhakkinan, U., Do, H.Q., Wong, J.C., Ford, C.S., "Convolutional Neural Networks for Additive Manufacturing Surrogate Models," Solid Freeform Fabrication Symposium, Austin, TX, Aug. 14-16, 2023.
35. **Wong, J.**, Sanders, E.D., Rosen, D.W., "Topology Optimization of Continuous Fiber-Reinforced Composites Considering Manufacturing Constraints, Solid Freeform Fabrication Symposium, Austin, TX, Aug. 14-16, 2023.
36. C Venkatesan, X Qi, YC Lee, MV Vellayapan, DNW Keong, HL Seet, S Nai, DW Rosen, "4D Printed Low-Weight Foaming Polylactic Acid: Process-Structure-Shape Memory Relationships," 4D Materials Design and Additive Manufacturing Conference, Atlanta, GA, USA, Sept. 8-9, 2023. *Best presentation in Asia and Oceania award*.
37. Ren, H., Xiong, Y., Rosen, D.W., "Topology Optimization Guided Continuous Path Planning for Additive Manufacturing of Fiber-reinforced Polymer Composites," International Conference on Design for 3D Printing," Jeju, South Korea, Oct. 19-21, 2023. *Best paper award*.

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38. Rosen, D.W., Sinha, A.K., Choi, C. “Product Architecture Design Benefits of Additive Manufacturing,” International Conference on Design for 3D Printing,” Jeju, South Korea, Oct. 19-21, 2023.
39. Liu, G., Rosen, D.W., “Multiphysics modelling of digital light processing 3D printing,” International Conference on Additive Manufacturing and Bio-Manufacturing, Beijing, China, March 29-31, 2024.
40. Ren, H., Rosen, D.W., Xiong, Y., “Concurrent design of composite structure and continuous toolpath for additive manufacturing of fiber-reinforced polymer composites,” International Conference on Computational & Experimental Engineering and Sciences, Singapore, Aug. 3-6, 2024.
41. Wang, Z.P., Rosen, D.W., “Bistable and multistable metamaterials: A comprehensive review and assessment,” International Conference on Computational & Experimental Engineering and Sciences, Singapore, Aug. 3-6, 2024.
42. Huang, J., Long, T.C., Seet, H.L., Nai, S., Rosen, D.W., “4D Printing of Polylactic Acid Hinges: A Study on Shape Memory Factors for Generative Design in a Digital Library Framework for Soft Robotics,” International Conference on Computational & Experimental Engineering and Sciences, Singapore, Aug. 3-6, 2024.
43. Wang, Z., Liu, J., Qi, X., Venkatesan, C., Nai, S., Rosen, D.W., “4D Printed Shape Memory Polymer Behavior Simulation and Validation,” International Conference on Computational & Experimental Engineering and Sciences, Singapore, Aug. 3-6, 2024.
44. Rosen, D.W., “Conceptual Design for 4D Additive Manufacturing,” Solid Freeform Fabrication Symposium, Austin, TX, Aug. 12-14, 2024.
45. Wang, Z.P., Rosen, D.W., “A Generalized Background Vector Method for Designing 3D Non-Periodic Woven Architectures,” TexComp-15 Conference, Leuven, Belgium, 11-13 Sept. 2024.
46. Silva, A., Kang, J., Rosen, D., “A twist on Sustainable Product Design post-graduate Education,” Asian Materials and Design Education Symposium, Singapore, Jan 14-16, 2025.
47. Wang, Z.P, Rosen, D.W., “Robust Design Optimization for Additively Manufactured Auxetic Structures,” International Conference on Materials for Advanced Technologies, Singapore, 30 June – 4 July, 2025.
48. Mi, Y, Rosen, D.W., “Immersed Isogeometric Analysis for General Shape-Memory Modeling and Simulation, 4D Materials Design and Additive Manufacturing Conference, Singapore, 8-10 July, 2025.
49. Zaw, M.M., Trubianov, M., Nai, S., Qi, X., Rosen, D.W., Andreeva-Baeumler, D., “Microfluidic Fabrication of Tunable 2D Material Core-Shell Functional Additives for Shape Memory Polymer Composites,” 4D Materials Design and Additive Manufacturing Conference, Singapore, 8-10 July, 2025.
50. Wang, Z.P., Mi, Y, Rosen, D.W., “Inverse Design of Temperature-Responsive Metamaterials Using Isogeometric Optimization,” 4D Materials Design and Additive Manufacturing Conference, Singapore, 8-10 July, 2025.
51. Qi, X., Luo, J., Chen, PY., Huang, J., Yang, J., Nai, S., Rosen, D.W., “In-Situ 4D Additive Manufacturing-Embedded Capacitive Sensor for Hinge Shape Change Monitoring,” 4D Materials Design and Additive Manufacturing Conference, Singapore, 8-10 July, 2025.
52. Yang, J., Chen, PY., Huang, J., Qi, X., Nai, S., Rosen, D.W., “From a compact volume to a curved surface through 4D additive manufacturing,” 4D Materials Design and Additive Manufacturing Conference, Singapore, 8-10 July, 2025.
53. Yang, X., Liu, G., Huang, J., Xu, Z., Rosen, D.W., “Retained Memory in Shape Memory Polymers: Mode-Specific Shape Recovery and Sequential Deformations,” 4D Materials Design and Additive Manufacturing Conference, Singapore, 8-10 July, 2025.
54. Pruksawan, S., Teo, R.L.J., Chong, Y.T., Rosen, D.W., Wang, F.K., “Additive Manufacturing of Geometrically Designed Hydrogel Metamaterials Exhibiting Negative Hydration Expansion,” 4D Materials Design and Additive Manufacturing Conference, Singapore, 8-10 July, 2025.
55. Xi, CY, Mi, YZ, Rosen, DW, “Switchable Diamond-Type Inertial Amplification Metamaterial for Low-Frequency Vibration Reduction in Corrugated-Core Sandwich Panels,” 4D Materials Design and Additive Manufacturing Conference, Singapore, 8-10 July, 2025.

56. Vellayapan, M.V., Qi, X., Rosen, D.W., Nai, S., "Pore-Encoded Shape Memory Programming Reducing Reliance on Complex Multi-Material Design for 4D Printing Applications," 4D Materials Design and Additive Manufacturing Conference, Singapore, 8-10 July, 2025.
57. Li, X., Wang, Z.P., Mi, Y., Rosen, D.W., Wang, Y., "Isogeometric Topology Optimization for Nonlinearities in 4D Printing Design," International Conference on Future of Additive Manufacturing, Singapore, Aug 5-8, 2025.
58. Huang, J., Chen, P., Luo, J., Yang, J., Qi, X., Rosen, D.W., Nai, SML., "A Self-deployable Parabolic Structure for Satellite Antenna Design Using Multi-Material 4D Additive Manufacturing Approach," ASTM International Conference on Additive Manufacturing, Las Vegas, NV, Oct 6-10, 2025.
59. Mi, YZ., Rosen, D.W., "General Shape Memory Modeling and Simulation using Isogeometric Analysis," ASTM International Conference on Additive Manufacturing, Las Vegas, NV, Oct 6-10, 2025.
60. Wang, ZP, Rosen, DW, "Robust Optimization for Structural Design, Maintenance, and Repair," Singapore Aerospace Technology and Engineering Conference (SATEC), 2026.
61. Yang, J., Liu, Y., Huang, J., Qi, X., Nai, S., Rosen, D.W., "Actuating origami-inspired deployable structures through 4D additive manufacturing," International Conference on Future of Additive Manufacturing, Singapore, Aug 2-4, 2026.
62. Qi, Q., Huang, J., Qi, NH.N., Rosen, D.W., Nai, S., "Mitigating electrical anisotropy in FDM-printed electronics via laser sintering of copper-flake filaments," International Conference on Future of Additive Manufacturing, Singapore, Aug 2-4, 2026.
63. Tang, R., Mi, Y., Rosen, D.W., "Efficient simulation of SMA morphing wings using physics-informed neural networks," International Conference on Future of Additive Manufacturing, Singapore, Aug 2-4, 2026.
64. Xing, Z., Mi, Y., Rosen, D.W., "Topology optimization design and deformation behavior control of SMA-actuated bistable structures," International Conference on Future of Additive Manufacturing, Singapore, Aug 2-4, 2026.

4. Invited Seminar Presentations

1. "Evaluation of the Noodles Solid Modeler and its Use in a Feature-Based Design System," Ford Scientific Research Lab, CAE Department, December 12, 1990.
2. "A Feature-Based Representation to Support Design-for-Manufacturing," ASME Boston Chapter, Computers in Mechanical Engineering Section, April 4, 1991.
3. "Conversions of Feature-Based Mechanical Design Representations for Manufacturability and Performance Analyses," presented at GWW School of Mechanical Engineering, Georgia Tech, January 29, 1992.
4. "The Role of Features in the Product Realization Process," presented at the Engineering Design Research Center, Carnegie Mellon University, October 22, 1992.
5. "Formal Properties of the Design/Manufacturing Interface," (with Dr. Tom Peters, University of Connecticut) at Dept. of Mechanical Engineering, University of South Carolina, Columbia, June 14, 1993.
6. "Software Architecture for Design and Analysis of Aircraft Evacuation Systems," presented at BFGoodrich R&D Center, Brecksville, OH, September 27, 1993.
7. "Topological Spaces for the Design/Manufacturing Interface," (with Dr. Tom Peters), Dept. of Informatics and Operations Research, University of Montreal, October 14, 1993.
8. "Environmentally Conscious Design," presented (with Dr. Bert Bras) to Chrysler managers and engineers at Georgia Tech, December 9, 1993.
9. "Georgia Tech Capabilities in CAE, Design and Manufacturing," presented (with Dr. Jonathan Colton) to Ford Powertrain Operations, Dearborn, MI, August 9, 1994.

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10. “Mechanical Engineering Perspectives on Computing and Software Engineering Education,” presented at the Software Engineering Workshop, University of Connecticut, Storrs, CT, August 18-19, 1994.
11. “The Systems Realization Laboratory at Georgia Tech,” presented to CAE Group at Ford Scientific Research Laboratory, Dearborn, MI, October 26, 1994.
12. “Virtual Prototyping in the Virtual Design Studio,” presented at Fraunhofer-IGD (Institute for Computer Graphics), Darmstadt, Germany, June 23, 1995.
13. “Rapid Physical and Virtual Prototyping in Product Development,” presented as part of a 3-day course on IPPD to Army program managers, sponsored by the National Center for Advanced Technologies, Crystal City, VA, July 13, 1995.
14. “Virtual Prototyping for Product Demanufacturing and Disassembly,” presented to the Recycling Group at Chrysler, Auburn Hills, MI, July 17, 1995.
15. “Extending the Domain of Problem Solving in CAD Systems - The Goal-Directed Geometry Formulation and Solution Method,” presented at the Institute for Applied Mathematics, Consiglio Nazionale delle Ricerche, Genoa, Italy, June 13, 1996.
16. “Reducing Cycle Time through Virtual & Rapid Prototyping Methods,” presented as part of a 3-day course on IPPD to Navy program managers, sponsored by the National Center for Advanced Technologies, Crystal City, VA, October 15-17, November 19-21, 1996.
17. “Parts, Prototypes, Plans, and Tools,” presented at the STEP-Based Workshop on Solid Interchange Formats at NIST, Gaithersburg, MD, November 25, 1996.
18. “Open Engineering Systems: From Life Cycle Design to Designing Product Families,” presented at the Ford Scientific Research Laboratory, Dearborn, MI, April 22, 1997.
19. “Investigations of Platform Commonality using Configuration Design Methods,” presented at the Ford Scientific Research Laboratory, Dearborn, MI, January 9, 1998.
20. “The Value of Prototypes in Engineering Design,” Special Design Seminar, University of Minnesota, November 3, 1998.
21. “The Georgia Tech Research Program in Rapid Prototyping and Manufacturing: Toward a Rapid Tooling Testbed,” Mechanical Engineering Department Seminar, University of Minnesota, November 4, 1998.
22. “Product Realization in a Distributed Engineering Environment,” NIST Manufacturing Systems Integration Division, with Farrokh Mistree, July 27, 1999.
23. “The Rapid Prototyping & Manufacturing Institute,” Gulfstream Advanced Design Group, March 8, 2001.
24. “Utility Theory Based Methods for Rapid Prototyping Selection,” Software Solutions for Rapid Prototyping Workshop, Hong Kong, July 5, 2001.
25. “Design Methods for Injection Molds and Applications to Rapid Tooling,” Department of Mechanical Engineering, University of Connecticut, November 21, 2001.
26. “The Rapid Prototyping & Manufacturing Institute,” Beckman-Coulter, Miami, FL, Sept. 26, 2002.
27. “The Rapid Tooling Testbed: A Distributed Design-For-Manufacturing System,” Dept. of Mechanical Engineering, University of Michigan, Sept. 18, 2003.
28. “Additive Manufacturing Technologies for Dental Restorations and Orthodontics,” School of Dentistry, Medical College of Georgia, Augusta, GA, February 4, 2004.
29. “Process Planning for Additive Manufacturing: Issues, Methods, and Challenges,” Dept. of Mechanical Engineering, Michigan Technological University, Houghton, MI, April 1, 2004.
30. “Process Planning and Design-for-Additive Manufacturing: Issues, Methods, and Challenges,” Dept. of Industrial Engineering, University at Buffalo, Buffalo, NY, Nov. 5, 2004.
31. “Additive Manufacturing Research in the RPMI,” Dept. of Mechanical and Manufacturing Engineering, Loughborough University, UK, July 19, 2005.

32. “Rapid Prototyping and Manufacturing,” Puerto Rico Manufacturers Association, Manufacturing Summit, San Juan, PR, Nov. 3-4, 2005.
33. “Cellular Structures: A New Material Mesostructure for Multifunctional Applications,” Invited seminar at the Department of Mechanical, Materials, and Aerospace Engineering, Illinois Institute of Technology, April 12, 2006.
34. “Cellular Structures: A New Material Mesostructure for Multifunctional Applications,” Invited seminar at the Department of Mechanical Engineering and Mechanics, Drexel University, Sept. 11, 2006.
35. “Cellular Structures and Adaptive Skins: Conceptual Materials for Multifunctional Applications,” invited seminar at NASA Langley, Hampton, VA, Dec. 1, 2006.
36. “Computer-Aided Design Methods for Additive Manufacturing,” School of Mechanical and Manufacturing Engineering, Loughborough University, June 3, 2008.
37. “Graduate Studies at the George W. Woodruff School of Mechanical Engineering,” Dept. of Mechanical and Automation Engineering, Chinese University of Hong Kong, Hong Kong, Oct. 13, 2008.
38. “Graduate Studies at the George W. Woodruff School of Mechanical Engineering,” Dept. of Mechanical Engineering, Shanghai Jiao Tong University, Shanghai, China, Oct. 14, 2008.
39. “Graduate Studies at the George W. Woodruff School of Mechanical Engineering,” Dept. of Mechanics & Aerospace Engineering, Peking University, Beijing, China, Oct. 15, 2008.
40. “Design for Additive Manufacturing,” Dept. of Precision Instruments & Mechanology, Tsinghua University, Beijing, China, Oct. 16, 2008.
41. “Design for Additive Manufacturing,” Dept. of Mechanical Engineering, Xi’an Jiao Tong University, Xi’an, China, Oct. 17, 2008.
42. “Graduate Studies at the George W. Woodruff School of Mechanical Engineering,” Dept. of Mechanical Engineering, Xi’an Jiao Tong University, Xi’an, China, Oct. 17, 2008.
43. “Design for Additive Manufacturing,” Dept. of Mechanical Engineering, Sungkyunkwan University, Suwon, Korea, Oct. 21, 2008.
44. “Graduate Studies at the George W. Woodruff School of Mechanical Engineering,” Dept. of Mechanical Engineering, Sungkyunkwan University, Suwon, Korea, Oct. 21, 2008.
45. “Design for Additive Manufacturing: Searching in Unexplored Regions of the Design Space,” Dept. of Mechanical Engineering, Seoul National University, Seoul, Korea, Oct. 22, 2008.
46. “Design for Additive Manufacturing: Exploiting the Unique Capabilities of Additive Manufacturing Processes,” Dept. of Mechanical Engineering, Iowa State University, Ames, IA, Oct. 20, 2009.
47. “Computer-Aided Design for Additive Manufacturing,” Dept. of Mechanical Engineering, Clemson University, Oct. 30, 2009.
48. “Roadmap for Additive Manufacturing: Identifying the Future of Freeform Processing,” Edison Welding Institute, Additive Manufacturing Consortium meeting, Columbus, OH, Feb. 11-12, 2010.
49. “Design for Additive Manufacturing: Opportunities with Cellular Structures,” Hong Kong University of Science and Technology, Dept. of Industrial Engineering, Dec. 15, 2010.
50. “Controlling Local Photopolymerization: Research in Stereolithography Manufacturing Processes,” Texas Tech University, Dept. of Mechanical Engineering, Oct. 17, 2011.
51. “Controlling Localized Photopolymerization: Research in Stereolithography Manufacturing Processes,” University of Southern California, Dept. of Industrial & Systems Engineering, Oct. 23, 2012.
52. “Computer-Aided Design for Additive Manufacture,” University of Connecticut, Dept. of Mechanical Engineering, Nov. 30, 2012.
53. “Additive Manufacturing: 3D Printing Processes, Applications, and Design Considerations,” Int’l Conf. on Engineering Design, Workshop on Additive Manufacturing, Seoul, Korea, Aug 19-22, 2013.

54. “Computer-Aided Design for Additive Manufacture,” Nanyang Technical University, School of Mechanical and Aerospace Engineering, Singapore, Sept. 25, 2013.
55. “Computer-Aided Design for Additive Manufacture,” Singapore University of Technology and Design, Singapore, Sept. 25, 2013.
56. “High Viscosity Ink-Jet Printing and Stereolithography 3D Printing Research,” School of Mechanical Science and Engineering, Jilin University, Changchun, China, July 17, 2014.
57. “High Viscosity Ink-Jet Printing and Stereolithography 3D Printing Research,” School of Mechanical Engineering and Automation, Northeastern University, Shenyang, China, July 18, 2014.
58. “Design and CAD for Additive Manufacturing,” GKN Aerospace, St. Louis, MO, Feb 27, 2015.
59. “Navigating Process-Structure-Property Relationships for Simultaneous Product-Material-Process Design,” Singapore University of Technology & Design, Engineering Product Development Pillar, March 18, 2015.
60. “Heterogeneous (Geometry+Materials) Modeling for Design for Additive Manufacturing,” Nanyang Technological University, Dept. of Mechanical and Aerospace Engr., Singapore, March 24, 2015.
61. “Heterogeneous (Geometry+Materials) Modeling for Design for Additive Manufacturing,” Institute for High Performance Computing, A*Star, Singapore, March 26, 2015.
62. “Towards Simultaneous Product-Material-Process Design for Additive Manufacturing,” Dept. of Mechanical Engineering, University of Illinois, Chicago, April 7, 2015.
63. “Process Modeling and Design for Additive Manufacturing,” Applied Materials, Inc., May 12, 2015.
64. “AlpZhi Technology and Commercialization,” Applied Materials Ventures, May 12, 2015.
65. “Computer-Aided Design and Optimization for Additive Manufacturing,” Siemens Energy, webinar, May 20, 2015.
66. “Modeling, Sensing, and Controlling High Precision Stereolithography,” Nanyang Technological University, Dept. of Mechanical and Aerospace Engr., Singapore, July 9, 2015.
67. “Design for Additive Manufacturing: Emerging Tools and Guidelines,” ASME AM3D, Boston, Aug. 10-12, 2015.
68. “ASTM International F42 Committee on Additive Manufacturing,” ASME Y14.46 Committee meeting, Boston, Aug. 12, 2015.
69. “Models of Distributed Properties: Towards Multi-Scale 4D Representations,” DARPA Design for Advanced Manufacturing workshop, Arlington, VA, Sept. 30, 2015.
70. “Towards Simultaneous Product-Material-Process Design for Additive Manufacturing,” Dept. of Mechanical Engineering, Politechnico di Milano, Milan, Italy, Oct. 2, 2015.
71. “Design for Additive Manufacturing,” Dept. of Mechanical Engineering, North Dakota State University, Fargo, ND, Oct. 16, 2015.
72. “Towards Simultaneous Product-Material-Process Design for Additive Manufacturing,” Dept. of Mechanical and Industrial Engineering, University of Massachusetts, Amherst, March 21, 2016.
73. “Design for Additive Manufacturing: Lattice Structures & Topology Optimization, Sandia Topology Optimization Workshop, Houston, TX, March 30, 2016.
74. “A Design Guidance System for Additive Manufacturing,” Siemens Energy, Orlando, FL, April 21, 2016.
75. “Towards Simultaneous Product-Material-Process Design for Additive Manufacturing,” Siemens Corporate Technology, Princeton, NJ, May 3, 2016.
76. “Additive Manufacturing: Processes and Trends,” Dept. of Mechanical Engineering, Sungkyunkwan University, Suwon, South Korea, Nov. 1, 2016.
77. “Entrepreneurship Initiatives at Georgia Tech and SUTD,” College of Engineering, Sungkyunkwan University, Suwon, South Korea, Nov. 2, 2016.

78. “Digital Manufacturing and Design Research at the Singapore University of Technology & Design,” Department of Industrial Systems Engineering, Asian Institute of Technology, Bangkok, Thailand, March 20, 2017.
79. “Digital Manufacturing and Design Research at the Singapore University of Technology & Design,” Department of Mechanical Engineering, King Mongkut University of Technology North Bangkok, Bangkok, Thailand, March 21, 2017.
80. “Process Measurement and Control of Mask Projection Stereolithography Processes,” School of Mechanical Science and Engineering, Huazhong University of Science and Technology, June 21, 2017.
81. “Additive Manufacturing Research at Georgia Tech and Singapore University of Technology & Design,” Wuhan National Laboratory for Optoelectronics, Huazhong University of Science and Technology, June 21, 2017.
82. “Process Measurement and Control for a Mask-Projection Stereolithography Process,” Department of Mechanical Engineering, Aalto University, Espoo, Finland, Oct. 13, 2017.
83. “Computer-Aided Design for Additive Manufacturing: Design with Geometry+Materials+Properties,” School of Mechanical Science and Engineering, Huazhong University of Science and Technology, June 12, 2018.
84. “Industrial Digital Design and Additive Manufacturing Workflows,” Shining 3D, Hangzhou, China, June 19, 2018.
85. “Additive Manufacturing Technologies and Applications,” College of Engineering, King Mongkut University of Technology North Bangkok, Bangkok, Thailand, August 2, 2019.
86. “Design for Additive Manufacturing: Opportunities and Challenges,” Dept. of Mechanical Engineering, Ecole Normale Superieure Paris-Saclay, Sept. 18, 2019.
87. “Multimaterial Digital Design Research,” LEGO Systems A/S, Billund, Denmark, Sept 15, 2019.
88. “Beyond Design for Manufacturing: Towards Simultaneous Product-Material-Process Design,” Dept. of Mechanical Engineering, Stevens Institute of Technology, Nov. 15, 2019.
89. “Design for Additive Manufacturing,” ASTM Center of Excellence Webinar, June 9, 2020.
90. “Design for Additive Manufacturing,” ASTM Center of Excellence Webinar, March 24, 2021.
91. “Design for Additive Manufacturing,” America Makes and ANSI Standards Workshop, March 31, 2021.
92. “Multi-scale Design of Fiber-Reinforced Composite Structures for Additive Manufacturing,” Sabanci University, Integrated Manufacturing Research and Application Center, (virtual) April 7, 2021.
93. “Design for Additive Manufacturing,” ASTM Center of Excellence Webinar, August 11, 2021.
94. “Perspectives on Design for Additive Manufacturing,” School of Aerospace and Mechanical Engineering, University of Oklahoma, Oct. 21, 2021.
95. “Digital Design and Manufacturing as a Cyber-Physical-Human System,” A*STAR Institute for High Performance Computing, Singapore, January 10, 2022.
96. “Design for the Additive Manufacturing Process Chain,” Department of Mechanical Engineering, Michigan State University, April 12, 2022.
97. “Advanced Manufacturing at A*STAR Singapore,” NIST Engineering Laboratory, Gaithersburg, MD, October 26, 2022.
98. “Design Exploration and Optimization Across Additive Manufacturing Process Chains,” Department of Mechanical and Aerospace Engineering, University of Pittsburgh, January 19, 2023.
99. “Co-Design Methods for Additive Manufacturing Process Chains,” DSO, Singapore, February 23, 2023.

100. "Additive Manufacturing Process Chains: Product-Process Co-Design Challenges and Opportunities," Technion Additive Manufacturing Center, Technion Israel Institute of Technology, Haifa, Israel, March 15, 2023.

101. "Design for Additive Manufacturing and Manufacturing Process Chains," Department of Engineering Science, Oxford University, April 25, 2023.

102. "Design and Additive Manufacturing Research at A*STAR," Department of Aerospace Engineering, Imperial College, London, UK, April 28, 2023.

103. "Design for Additive Manufacturing Process Chains: Applications of Systems Engineering Methods," Systems Engineering Community of Practice Seminar Series, A*STAR, Singapore, June 30, 2023.

104. "Design for Additive Manufacturing," Incheon National University, Incheon, South Korea, Sept. 18, 2023.

105. "Developing Additive Manufacturing Solutions – Towards an Integrated End-to-end Platform," Lawrence Livermore National Laboratory, Materials Science Division, Oct 27, 2023. (80 pax)

106. "Developing Additive Manufacturing Solutions – Towards an Integrated End-to-end Platform," Oak Ridge National Laboratory, Materials Science Division, Oct 29, 2023. (20 pax)

107. "4D Additive Manufacturing: Concepts and Design Approaches," Department of Engineering Science, Oxford University, April 16, 2024. (12 pax)

108. "Toward Cybermanufacturing: Advances in Machine Learning and Design Optimization," Center for Advanced Manufacturing, University of Southern California, Oct. 25, 2024. (15 pax)

109. "DLP Stereolithography Process Simulation," TE Corporate Technology, Nov. 20, 2024.

110. "Digital Design and Manufacturing Workflows for Faster Product Development," ST Engineering Land Systems, Management Workshop, February 24, 2025.

111. "Artificial Intelligence in Cyber Manufacturing," City University of Hong Kong, Hong Kong, March 26, 2025.

112. "Artificial Intelligence in Cyber Manufacturing," Hong Kong University of Science and Technology, Hong Kong, March 28, 2025.

113. "Artificial Intelligence in Cyber Manufacturing," Southern University of Science and Technology, Shenzhen, China, March 31, 2025.

114. "Generative Design for Additive and Subtractive Manufacturing," City University of Hong Kong, Hong Kong, December 17, 2025.

E. Grants and Contracts

1. As Principal Investigator

At Georgia Tech:

1. Virtual Design, Service, and Demanufacture Studio
   National Science Foundation
   PI. Collaborators: Farrokh Mistree, Bert Bras, Nelson Baker (CEE), and Ashok Goel (COC).
   Total Dollar Amount: $417,000. Period of Contract: 10/94 – 9/97.
   Candidate's Share: ~33% ($139K)
2. Ship Design for Producibility
   PI
   US Navy, subcontract under Advanced Marine Enterprises, Inc.
   Total Dollar Amount. $55,892. Period of Contract: 1/95 – 12/95.
3. A Rapid Tooling Testbed for Injection Molding
   National Science Foundation.
   PI: David Rosen, Co-PIs: Janet Allen, Jonathan Colton, Thomas Kurfess, Farrokh Mistree, Thomas Starr (MSE), Richard Fujimoto (COC), Karsten Schwan (COC).

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Total Dollar Amount: $1,350,000. Period of Contract: 9/97 – 8/00.
Candidate's Share: ~33% ($450)

4. The Product Family Reasoning System – Design Methods for Enabling Product Variety
   National Science Foundation
   PI. Total Dollar Amount: $168,218. Period of Contract: 1/1999 - 12/2001.
5. Characterization of PVA for use in Stereolithography Machines
   CibaVision Corp.
   PI. Total Dollar Amount: $137,400. Period of Contract: 3/2002 - 4/2004.
6. Paper Machine Clothing Research
   Albany, International.
   PI. Co-PIs: Jonathan Colton, Cliff Henderson, John Muzzy
   Total Dollar Amount: $63,000. Period of Contract: 1/04 - 12/04
   Candidate's Share: ~25% ($16k)
7. Development and Commercialization of MicroStereolithography (MSLA) Technology
   National Collegiate Inventors and Innovators Alliance.
   PI. Co-PI: Marie Thursby
   Total Dollar Amount: $17,000. Period of Contract: 7/04 - 6/05
   Candidate's Share: 100%
8. Stereolithography for Corrective Lens Manufacturing
   Georgia Research Alliance
   PI. Total Dollar Amount: $47,600. Period of Contract: 7/04 - 6/05
9. Characterization of PVA for use in Stereolithography Machines
   CibaVision Corp.
   PI. Total Dollar Amount: $55,100. Period of Contract: 1/05 - 12/05
10. Paper Machine Clothing Research
    Albany, International.
    PI. Co-PIs: Jonathan Colton, Cliff Henderson, John Muzzy
    Total Dollar Amount: $81,000. Period of Contract: 1/05 - 12/05
    Candidate's Share: ~50% ($40.5k)
11. Synthesis Methods for Structural and Compliant Mesostructured Parts
    National Science Foundation.
    PI. Total Dollar Amount: $190,000. Period of Contract: 8/05 - 7/08.
12. Stereolithography for Corrective Lens Manufacturing
    Georgia Research Alliance
    PI. Total Dollar Amount: $50,000, Period of Contract: 9/05 - 8/06
13. Paper Machine Clothing Research
    Albany, International.
    PI. Co-PI: Cliff Henderson
    Total Dollar Amount $81,000. Period of Contract: 1/06 - 12/06
    Candidate's Share: 50% ($40.5k)
14. CustomVision
    Georgia Tech VentureLab program.
    PI. Total Dollar Amount: $50,000. Period of Contract: 9/06 - 6/07
15. Cytometer Housing Manufacture Research
    RMD, Inc. subcontract from NASA SBIR.
    PI: Total Dollar Amount: $10,000. Period of Contract: 12/05 - 5/06
16. Development of an Implantable Artificial Kidney
    Mason Trust Foundation.
    PI. Co-PI: David Ku
    Total Dollar Amount: $480,000. Period of Contract: 8/06 - 1/10

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17. Cytometer Housing Manufacture Research
RMD, Inc. subcontract from NASA SBIR.
PI. Total Dollar Amount: $75,000. Period of Contract: 1/07 - 12/08

18. Manufacturing Research for Paper Machine Clothing
Albany, International.
PI. Co-PI: Cliff Henderson
Total Dollar Amount: $85,000. Period of Contract: 1/07 - 12/07

19. Characterization of PVA for use in Stereolithography Machines
CibaVision Corp.
PI. Co-PIs: V. Breedveld, M. Gallivan, C. Henderson
Total Dollar Amount: $621,000. Period of Contract: 3/07 - 2/10
Candidate's Share: ~50% ($310k)

20. Stereolithography for Corrective Lens Manufacturing
Georgia Research Alliance
PI. Co-PIs: V. Breedveld, M. Gallivan, C. Henderson
Total Dollar Amount: $94,000. Period of Contract: 7/07 - 6/08
Candidate's Share: ~33% ($31k)

21. Drop-on-Demand Deposition of Complex Fluids for 3-D Manufacturing
National Science Foundation.
PI, co-PIs: F. L. Degertekin, A. Fedorov.
Total Dollar Amount: $371,000. Period of Contract: 7/09 - 6/12
Candidate's Share: ~40% ($140k)

22. A Multiscale Heterogeneous Foundation for Computer-Aided Design,
National Science Foundation
PI. co-PI: Yan Wang
Total Dollar Amount: $359,000. Period of Contract: 9/10 - 8/13
Candidate's Share: 50% ($180k)

23. Film Microstereolithography Process.
Georgia Research Alliance, VentureLab program.
PI. Total Dollar Amount: $50,000. Period of Contract: 7/10 - 6/11.

24. Infusion Finger Pumps for Biomedical Applications.
Georgia Research Alliance, VentureLab program.
PI. co-PI: David Ku.
Total Dollar Amount: $25,000. Period of Contract: 9/10 - 6/11.
Candidate's Share: ~75% ($19k)

25. Film MicroStereolithography for Microlens Fabrication
NSF SBIR, subcontract from AlpZhi, Inc.
PI. Total Dollar Amount: $38,000. Period of Contract: 1/11 - 6/11.

26. Interdisciplinary Undergraduate Design Minor.
GT FIRE Program.
PI. co-PIs: Sabir Khan, Ali Mazalek.
Total Dollar Amount: $38,000. Period of Contract: 5/11 - 4/13.
Candidate's Share: 50% ($19k)

27. Workshop on Mechanical Engineering Design Knowledge Modeling
National Science Foundation.
PI. co-PI: J. Summers (Clemson U).
Total Dollar Amount: $47,314. Period of Contract: 8/11 - 7/13
Candidate's Share: ~70% ($33k)

28. Film Microstereolithography Process
Georgia Research Alliance, VentureLab program, Phase IIa.
PI. Total Dollar Amount: $50,000. Period of Contract: 7/11 - 6/12.

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29. Sensing and Control of Photopolymerization-Based Additive Manufacturing Processes.
National Science Foundation
PI. Total Dollar Amount: $269,000. Period of Contract: 8/12-7/15.
30. AlpZhi, Inc., Film Microstereolithography Process.
Georgia Research Alliance, VentureLab program, Phase IIB.
PI. Total Dollar Amount: $50,000. Period of Contract: 7/12 - 6/13.
31. Exposure Controlled Projection Lithography for Fabrication of Physical Shaped GRIN Optics,.
NSF SBIR, subcontract from AlpZhi, Inc.
PI. Total Dollar Amount: $36,442. Period of Contract: 7/13-12/13.
32. Optimal Design of New Door Operator
ThyssenKrupp Elevators.
PI. co-PI: Seung-Kyum Choi.
Total Dollar Amount: $29,000. Period of Contract: 6/2014 – 9/2014.
Candidate's Share: 50% ($14,500).
33. Reinforced Polymers for Material Extrusion Additive Manufacturing
Imerys Corp.
PI. co-PI: Meisha Shofner.
Total Dollar Amount: $200,000. Period of Contract: 6/2014 – 9/2016.
PI Share: 55% ($110,000)
34. Materials and Processes for High Aspect Ratio Features on Dryer Fabrics
Kimberly-Clark Corp.
PI. co-PI: Meisha Shofner.
Total Dollar Amount: $425,000, 1/2015 – 12/2018.
Candidate's Share: 20% ($85,000).
35. AlpZhi, Inc., Film Microstereolithography Process.
Georgia Research Alliance, VentureLab program, Phase IIC.
PI. Total Dollar Amount: $50,000. Period of Contract: 11/14 - 6/15.
36. A Design Guidance System for Additive Manufacturing.
America Makes.
PI. co-PI: C. Seepersad (U Texas), S.Musuvathy (Siemens), J. Berlin (Stratasys)
Total Dollar Amount: $999,959, Cost Share: $1.08M. Period of Contract: 10/15 – 9/17.
Candidate's Share: ~25% ($276,000).
37. Product Family Configuration System
Wincor-Nixdorf, Inc.
PI. Total Dollar Amount: $30,768. Period of Contract: 9/15 – 11/15.

At SUTD:

38. Computer-Aided Design for Additive Manufacturing: Simultaneous Product-Material-Process Design
Digital Manufacturing and Design research center, Singapore University of Technology & Design.
PI. Co-PIs: Q. Ge, N. Raghavan.
Total Dollar Amount: US$1,080,000. Period of Performance: 4/17-9/20
Candidate's Share: ~50% ($500k)
39. Standards for Design Rules for Additive Manufacturing
National Additive Manufacturing Innovation Cluster (Singapore).
PI. Co-PI: KH Lim (SUTD).
Total Dollar Amount: US$144,000. Period of Contract: 5/17-4/19
Candidate's Share: 80% ($115k)
40. Integration of Fiber Reinforced Composites and Additive Manufacturing — CPV Pressure Reducer
National Additive Manufacturing Innovation Cluster (Singapore)
PI. Total Dollar Amount: US$64,300. Period of Contract: 7/17 – 6/18.

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41. Micro-optics Component Fabrication using Mask Projection Stereolithography
National Additive Manufacturing Innovation Cluster (Singapore).
PI. Total Dollar Amount: US$166,000. Period of Contract: 8/17-7/19.
42. Standards and Framework Equivalency Methodology Development for Additive Manufacturing of Engineering Components
National Additive Manufacturing Innovation Cluster (Singapore).
PI. Total Dollar Amount: US$108,670. Period of Contract: 4/18-3/19.
43. AI in Metrology for Additive Manufacturing
Digital Manufacturing and Design research center, Singapore University of Technology & Design.
PI. Total Dollar Amount: US$265,000. Period of Performance: 4/18-9/20
44. Additive Manufacturing Standards for the Singapore Armed Forces
National Additive Manufacturing Innovation Cluster (Singapore).
PI. Total Dollar Amount: US$180,450. Period of Contract: 12/18-12/20.
45. Standard Development for Additive Manufacturing Material: Maraging Steel
National Additive Manufacturing Innovation Cluster (Singapore).
PI. Total Dollar Amount: S$101,400, US$75,000. Period of Contract: 8/2020-3/2021.

At A*STAR:

46. DLP Process Simulation, Phase 1
TE Connectivity.
PI. Total Dollar Amount: S$110,000. Period of Performance: 3/2024 – 8/2025
47. 4D Additive Manufacturing of Smart Structures
MTC Programmatic Fund
PI. Co-PIs: Sharon Nai, Wang FuKe, Pablo Valdivia, Zhou Kun, Daria Andreeva, Liu Jun
Total Dollar Amount: S$14,542,060. Period of Contract: 8/2024 – 7/2027.
48. Digital Part Passport
National Additive Manufacturing Innovation Cluster (NAMIC)
PI. Total Dollar Amount: S$146,874. Period of Performance: 1/2025 – 3/2026.

2. Co-Principal Investigator

At Georgia Tech:

1. Development of an Integrated and Collaborative Design-Learning Simulator
Joint proposal with Janet Allen and Farrokh Mistree (ME) and Mark Guzdial (CoC).
GT EduTech Program
Amount Requested: $26,300, 1 Year, March 1994. Result: Awarded (6/94 – 5/95)
2. Design for Demanufacturing
GT Manufacturing Research Center. Joint with Bert Bras and Kok-Meng Lee.
Amount Requested: $86,783, 1 year. Result: Awarded. $15,000 (9/94 – 9/95).
3. Computer-Aided Design for Demanufacturing and Remanufacturing
National Science Foundation Joint with Bert Bras.
Amount Requested: $257,480, 3 yrs. Result: Awarded: $217,000 (9/94 – 8/97).
4. Design for Automated Demanufacturing of Electronic Products
GT Manufacturing Research Center. Joint with Bert Bras and Kok-Meng Lee.
Amount Requested: $40,000, 1 year. Result: Awarded. $32,000. (9/95 – 8/96).
5. Distributed Design and Manufacturing: A Practical Usage Scenario
NIST. PI: Farrokh Mistree. Co-PI's: Janet Allen and David Rosen
Amount Requested: $50,000. 1 year. Result: Awarded (10/99), $25,000, 1 year.
6. Laser-Jet CVD Rapid Prototyping of Electronic Devices and Laminated Materials
National Science Foundation.
PI: Jack Lackey, Co-PI's: Iwona Jasiuk and David Rosen.

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Total Dollar Amount: $320,000. Period of Contract: 4/00 - 3/03
Candidate's Share: ~33% ($100k)

7. ITR/PE+SY Digital Clay for Shape Input and Display
National Science Foundation.
PI: Wayne Book. Co-PIs: M. Allen, I. Ebert-Uphoff, A. Glezer, D. Rosen, J. Rossignac
Total Dollar Amount: $2,000,000. Period of Contract: 9/01 - 8/06
Candidate's Share: ~12% ($250k)
8. Development of a Microfabricated Miniature Fuel Cell
T/J Technology (NIST ATP contract).
PI: Peter Hesketh. Co-PI: Paul Kohl, D. Rosen
Total Dollar Amount: $350,000. Period of Contract: 6/03 - 7/04
Candidate's Share: ~20% ($65k)
9. Roadmap for Additive Manufacturing Workshop
NSF and ONR
PI: David Bourell (Univ. Texas). Co-PIs: D. Rosen, M. Leu (Missouri Univ S&T).
Total Dollar Amount: $75,000. Period of Contract: 1/09 - 12/09.
Candidate's Share: 10% ($7.5k)
10. Design and Manufacturing of a Surgical Support Structure
VentureLab.
PI: Tim Olsen (Emory U). co-PIs: S. Melkote, D. Rosen
Total Dollar Amount: $50,000. Period of Contract: 1/09 – 12/09.
Candidate's Share: 17% ($8.5k)
11. Tissue Support for Suprachoroidal Surgery
Emtech Bio program.
PI: Tim Olsen (Emory U). co-PIs: S. Melkote, D. Rosen
Total Dollar Amount: $100,000. Period of Contract: 9/09 - 8/10
Candidate's Share: 20% ($20k)
12. CCLI: Biologically !nspired Design: A novel interdisciplinary biology-engineering curriculum,
National Science Foundation
PI: Jeannette Yen, co-PIs: A. Goel, D. Rosen, C. Tovey, M. Weissburg.
Total Dollar Amount: $600,000. Period of Contract: 9/10 - 8/12
Candidate's Share: ~7% ($40k)
13. Ultralight-but-Robust Automotive Vehicle with Strong, Lightweight, Next-generation Material.
Korea Institute for Advancement of Technology.
PI: Seung-Kyum Choi. co-PI: Richard Neu, David Rosen
Total Dollar Amount: $35,000. Period of Contract: 1/2011 - 6/2011
Candidate's Share: 20% ($7k)
14. MENTOR: Manufacturing Experimentation and Outreach
DARPA, MENTOR program.
PI: Dan Schrage (AE). co-PI: David Rosen.
Total Dollar Amount: $1,000,000. Period of Contract: 9/11 - 8/12
Candidate's Share: 12% ($120k)
15. Development of iFAB Manufacturing Process and Machine Capability Library
DARPA, iFAB program.
PI: Shreyes Melkote). co-PI: David Rosen and 6 others.
Total Dollar Amount: $1,468,644. Period of Contract: 6/11 - 5/12
Candidate's Share: ~8% ($100k)
16. Reliability-based Design and Manufacturing of Cellular Structures
National Science Foundation
PI: S-K. Choi. co-PI: D Rosen.
Total Dollar Amount: $375,000. Period of Contract: 8/2012 - 7/2015.
Candidate's Share: ~40% ($170,000).

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17. Analytical Certification for Additive Manufacturing Parts and Processes under Uncertainty
National Science Foundation
PI: S-K. Choi. co-PI: D Rosen.
Total Dollar Amount: $100,000. Period of Contract: 8/2015-7/2018.
Candidate's Share: ~10% ($10,000).

18. Enhancing the Model-Based Definition with Manufacturing Information through Linked Data for Design Exploration
DMDII
PI: Veronica Brandstetter (Siemens CT). co-PIs: DW Rosen, others at Siemens, Koneksys, MetaMorph, Raytheon
Total Dollar Amount: $1,000,000. Period of Contract: 18 months. Selected for award Feb 2017. Suspended due to a company's withdrawal from the project. Assigned to S. Melkote since I was on leave-of-absence. Project was reactivated in Oct 2018.
Candidate's Share: $134,477

19. A Data-Driven Approach to Future Cyber Manufacturing as a Service
National Science Foundation
PI: S Melkote. Co-PI: D Rosen
Total Dollar Amount: $300K. Period: 24 months. Awarded March 2021
Candidate's share: $140,000

20. FMRG: Manufacturing USA: Cyber: Data-Driven Methods for Future Cyber Manufacturing as a Service
National Science Foundation
PI: S Melkote. Co-PI: M. Dinar, M. Gombolay, D Rosen
Total Dollar Amount: $2M. Period: 48 months. Awarded August 2022
Candidate's share: $650,000

At SUTD

21. 3D Printing Architecture: Digital Design and Manufacturing of Bespoke Space Frames using Additive Manufacturing,
SUTD/Zhejiang University Research Collaboration Grant
PI. F. Raspall, co-PI C Banon, DW Rosen.
Total Dollar Amount: US$552,000. Period of Contract: 8/2017 – 7/2020.
Candidate's Share: ~38% ($211,000)

22. Industrial Digital Design and Manufacturing Workflows
Advanced Manufacturing Enterprise Program, Singapore.
Co-PI. PI: A Silva. Co-PIs: YW Zhang, S. Narayanaswamy, GS Soh, DW Rosen.
Total Dollar Amount: US$11,000,000. Period of Contract: 3/2020 – 2/2023.
Candidate's Share: ~11% ($1.2M)

23. An Integrated Sense-Analysis-Print Process for On-demand Printing of Insoles
National Additive Manufacturing Innovation Cluster (Singapore).
PI. Total Dollar Amount: S$230,400, US$170,000. Period of Contract: 8/2019-6/2021
Candidate's Share: 75% (S$172,800, US$127,000)

F. Other Scholarly and Creative Accomplishments

Start-Up Companies

1. AlpZhi, Inc. Incorporated Nov. 2009. Founders: A.S. Jariwala, F. Ding, D.W. Rosen. Commercializing the mask-projection stereolithography technology developed during a Ciba Vision research contract. Awarded two NSF SBIR grants and four GT VentureLab grants.
2. Additive Manufacturing Technologies, Inc. Founded March 2010. Founders: J. Williams, D.W. Rosen. Commercializing the TrussCreator software for lightweight structure design that was developed during an NSF grant and Air Force contract.

G. Societal and Policy Impacts

no data

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H. Other Professional Activities

Engineering Consulting

1. Lawrence Livermore National Laboratory. Assessment of Competitive Product and Process Design Strategies. 6/26/94 - 7/13/94.
2. Albany International. Evaluation of Droplet Generation Manufacturing Methods. Nov. 2007.
3. Boeing. Methods for Eliminating STL Files. Nov.-Dec. 2007.
4. Albany International. Evaluation of droplet generation manufacturing methods; expert witness on patent litigation. June - Sept 2009.
5. EOS, GmbH. Expert witness in tariff litigation regarding classification of their laser sintering and melting machines. May 2010 - April 2011.
6. Align Technology, member Scientific Advisory Board, 2013. Board meeting Jan 10-11, 2013.
7. ExOne Corp., Software Environment for Additive Manufacturing. Aug-Dec, 2013.
8. Waldemar Link GmbH, Nov. 2019.
9. Xometry. Evaluate 3D Hubs online quoting system. Aug-Sept 2020.
10. Markforged. Patent challenges. 2022.

V. TEACHING

A. Courses Taught

Semester, Year	Course Number	Course Title	No. Students
Spring 2022	ME 2016-C	Computing Techniques	52
Spring 2022	ME 2016-D	Computing Techniques	55
Fall 2021	ME 6124-A	Finite Element Method	35
Fall 2021	ME 6124-Q	Finite Element Method	12
Spring 2021	ME 6104-A	Fundamentals of CAD	21
Spring 2021	ME 6104-Q	Fundamentals of CAD	9
Spring 2021	ME 6124-A	Finite Element Method	21
Spring 2021	ME 6124-Q	Finite Element Method	9
Fall 2020	ME 6124-A	Finite Element Method	21
Fall 2020	ME 6124-Q	Finite Element Method	9
Summer 2020	ME 6124-A	Finite Element Method	10
Summer 2020	ME 6124-Q	Finite Element Method	7
Spring 2020	ME 7227-A	Rapid Prototyping in Engineering	22
Spring 2020	ME 7227-Q	Rapid Prototyping in Engineering	20
Spring 2020	ME 2016	Computing Techniques	40
Fall 2019	ME 3801	Intro to Additive Manufacturing	10
Fall 2019	ME 6124-A	Finite Element Method	41
Fall 2019	ME 6124-Q	Finite Element Method	14
Spring 2019	ME 2016	Computing Techniques	36
Fall 2018	ME 6124-A	Finite Element Method	33
Fall 2018	ME 6124-Q	Finite Element Method	18
Spring, 2016	ME 6104-A	Fundamentals of CAD	44
Spring, 2016	ME 6104-Q	Fundamentals of CAD	23

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Fall 2015	ME 4803	Design Across Disciplines	11
Spring, 2015	ME 6104-A	Fundamentals of CAD	44
Spring, 2015	ME 6104-Q	Fundamentals of CAD	26
Fall, 2014	ME 7227-A	Rapid Prototyping in Engineering	20
Fall, 2014	ME 7227-Q	Rapid Prototyping in Engineering	18
Spring, 2014	ME 6104-A	Fundamentals of CAD	31
Spring, 2014	ME 6104-Q	Fundamentals of CAD	15
Fall, 2013	ME 4803	Design Across Disciplines	8
Spring, 2013	ME 6104-A	Fundamentals of CAD	28
Spring, 2013	ME 6104-Q	Fundamentals of CAD	13
Spring, 2013	ME 4803	Design Across Disciplines	6
Spring, 2012	ME 6104	Fundamentals of CAD	25
Spring, 2012	ME 6104-Q	Fundamentals of CAD	4
Spring, 2011	ME 6104	Fundamentals of CAD	30
Fall, 2010	ME 7227	Rapid Prototyping in Engineering	21
Spring, 2010	ME 6104	Fundamentals of CAD	50
Spring, 2009	ME 6104	Fundamentals of CAD	30
Spring, 2008	ME 6104	Fundamentals of CAD	32
Spring, 2007	ME 6104	Fundamentals of CAD	30

B. Individual Student Guidance

1. Ph.D. Students

a) Graduated

1. Scott Pierce Began advising during Summer 1994. Passed Ph.D. Qualifiers: Fall 1993. Graduation date: Summer 2003. Current Position: Assistant Professor, Western Carolina University.
   Dissertation Title: A Method for Integrating Form Errors into Tolerance Analysis.
   Journal Publications: IV.B.41, IV.B.44. Conference Publications: IV.B.24, IV.B.31, IV.B.38, IV.B.81, IV.B.82.
2. Zahed Siddique Began advising as Ph.D. student Summer 1996. Passed Ph.D. Qualifiers: Spring 1997. Graduation date: May 2000.
   Dissertation Title: Common Platform Development: Designing for Product Variety.
   Position: Associate Professor, University of Oklahoma.
   Journal Publications: IV.B.13, IV.B.17, IV.B.22. Book Chapters: IV.A.1, IV.A.5.
   Conference Publications: IV.B.23, IV.B.25, IV.B.35, IV.B.39, IV.B.42, IV.B.43, IV.C.25, IV.C.33. Other Publications: IV.C.4.1.
3. Yong Chen Began advising as Ph.D. student Spring 1998. Passed Ph.D. Qualifiers: Spring 1999.
   Graduated: Fall 2001. Position: Associate Professor, University of Southern California.
   Dissertation Title: Computer-Aided Design for Rapid Tooling: Methods for Mold Design and Design-for-Manufacture
   Journal Publications: IV.B.28, IV.B.30, IV.B.31, IV.B.33, IV.B.47. Conference Publications: IV.B.45, IV.B.49, IV.B.53, IV.B.54, IV.B.57, IV.B.62, IV.B.65, IV.B.84, IV.B.85
4. Hongqing Wang Began Ph.D. studies Fall 2001. Passed Ph.D. Qualifiers: Spring 2001. Graduation: December 2005. Position: Analyst at Wells Fargo
   Dissertation Title: A Unit Cell Approach for Lightweight Structure and Compliant Mechanism
   Conference Presentations: IV.B.58, IV.B.63, IV.B.68, IV.B.84, IV.B.85, IV.B.90, IV.B.93, IV.C.42, IV.C.60, IV.C.61, IV.C.62, IV.C.63, IV.D.13 (w/o proceedings).

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5. Laam Angela Tse Began advising Fall 2002. Passed Ph.D. Qualifiers: Spring 2004. Presented Proposal: 10/2004. Graduation: Summer 2006. Position: Manufacturing Engineer at Baker-Hughes.
   Dissertation Title: Membrane Electrode Assembly (MEA) Design for Power Density Enhancement of Direct Methanol Fuel Cells (DMFCs)
   Journal Publications : IV.B.29, IV.B.35. Conference Presentations: IV.B.89, IV.C.27, IV.C.28, IV.C.30, IV.C.34, IV.C.35, IV.C.36, IV.C.37, IV.C.54, IV.C.57.
6. Benay Sager Began Ph.D. studies Summer 2003. Passed Ph.D. Qualifiers: Spring 2004. Presented Proposal: 10/2004. Graduation: Spring 2006. Position: Consultant, McKinsey.
   Dissertation Title: SLA Characterization for Surface Finish Improvement: Inverse Design Methods for Process Planning
   Book Chapter: IV.A.10. Journal Publications: IV.B.50. Conference Presentations: IV.B.74, IV.B.79, IV.C.38, IV.C.44, IV.C.55, IV.C.58, IV.C.59, IV.D.14 (w/o proceedings).
7. Christopher Williams Began Ph.D. studies Spring 2004. Co-Advisor: Dr. F. Mistree. Graduation: Spring 2008. Position: Associate Professor at Virginia Tech
   Dissertation Title: Design and Development of a Layer-Based Additive Manufacturing Process for the Realization of Metal Parts of Designed Mesostructure
   Book Chapter: IV.A.7. Journal Papers: IV.B.47, IV.B.57, IV.B.60. Conference Presentations: IV.B.64, IV.B.76, IV.B.80, IV.B.88, IV.B.94, IV.B.95, IV.C.63.
8. Nsikan Udoyen Began advising Summer 2004. Presented Proposal: 11/2004. Co-Advisor: Dr. F. Mistree. Graduation date: Fall 2006. Position: Manufacturing engineer, Intel.
   Dissertation Title: Information Modeling for Intent-Based Retrieval of Parametric Finite Element Analysis Models
   Journal Publications: IV.B.49, IV.B.52. Conference Presentations: IV.B.92
9. Sungshik Yim Began advising Summer 2004. Defended dissertation: Nov. 2006. Graduation: 5/2007.
   Dissertation Title: A retrieval method (DFM framework) for automated retrieval of design for additive manufacturing problems. Position: Unknown.
   Journal Publications: IV.B.48. Conference Presentations: IV.B.97, IV.B.105, IV.C.64, IV.D.16 (w/o proceedings)
10. Greg Mocko Began advising Fall 2004. Presented Proposal: 12/2004. Co-Advisor: Dr. F. Mistree. Graduation: Spring 2006. Position: Associate Professor at Clemson University
    Dissertation Title: A Knowledge Framework for Integrating Multiple Perspectives in Decision-Centric Design
    Conference Presentations: IV.B.91, IV.B.96
11. Ameya Limaye Began Ph.D. studies Fall 2004. Passed Ph.D. Qualifiers: Fall 2005. Graduation: Fall 2007. Position: Manufacturing engineer at Intel.
    Dissertation Title: Process planning method for Mask Projection Stereolithography
    Journal Publications: IV.B.39, IV.B.40. Conference Presentations: IV.B.73, IV.B.78, IV.D.54, IV.D.56, IV.D.67.
12. Jamal Wilson Began Ph.D. studies Fall 2005. Passed Ph.D. Qualifiers: Spring 2005. Graduation: Fall 2008. Position: R&D engineer, Coca-Cola
    Dissertation Title: A Systematic Approach to Bio-Inspired Conceptual Design
    Book Chapter: IV.A.8. Journal Publications: IV.B.54, IV.B.55. Conference Presentations: IV.B.86, IV.B.98, IV.B.105, IV.D.16 (w/o proceedings).
13. Amit Jariwala Began advising Fall 2007. Graduation: May 2013.
    Position: Director of Design & Innovation, ME School, Georgia Tech
    Dissertation Title: Modeling and Process Planning for Exposure Controlled Projection Lithography
    Journal Publications: IV.B.59, IV.B.66. Conference Presentations: IV.B.101, IV.B.107, IV.B.110, IV.B.122, IV.B.126, IV.B.138, IV.C.81, IV.C.84, IV.C.88, IV.C.95.

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14. Jane Kang Began advising Fall 2008. Co-advisor: C. Aidun. Passed Ph.D. Qualifiers: Fall 2010. Graduation: Summer 2015. Position: Wireline engineer, Schlumberger.
Dissertation Title: Migration of Blood Cells in Non-Uniform Suspension for a Dialyzer Design
Journal Publications: IV.B.61, IV.B.1 (submitted). Conference Presentations: IV.B.113, IV.B.122, IV.C.72.

15. George Mathai Began co-advising with Dr. Shreyes Melkote Fall 2008. Passed Ph.D. Qualifiers: Spring 2009. Graduation: Fall 2012. Position: Manufacturing engineer, Caterpillar.
Abrasive Assisted Brush Deburring of Micromilled Features with Application to a Novel Surgical Device
Journal Publications: IV.B.68, IV.B.69, IV.B.73. Conference presentations: IV.B.123, IV.B.124. IV.B.132.

16. Namin Jeong Began advising Fall 2009. Passed Ph.D. Qualifiers: Spring 2011. Graduation: Fall 2015. Position: none.
Dissertation Title: A Surfacelet-Based Method for Constructing Geometric Models of Microstructure
Journal Publications: IV.B.67, IV.B.82. Conference presentations: IV.B.119, IV.B.134, IV.C.80, IV.C.85, IV.C.91, IV.C.94, IV.C.100.

17. Wenchao Zhou Began advising Fall 2009. Passed Ph.D. Qualifiers: Fall 2010. Graduation: Spring 2014. Position: Associate Professor at University of Arkansas.
Dissertation Title: Interface Dynamics in Inkjet Deposition
Journal Publications: IV.B.63, IV.B.70; IV.B.77, IV.B.78. Conference presentations: IV.B.111, IV.B.116, IV.B.118, IV.B.137, IV.C.79, IV.C.85, IV.C.96.

18. Dazhong Wu Began co-advising with Dr. Dirk Schaefer Fall 2011. Passed Ph.D. Qualifiers: Spring 2011. Graduation: Fall 2014. Position: Assistant Professor at University of Central Florida
Dissertation Title: Cloud-Based Design and Manufacturing: A Network Perspective
Journal Publications: IV.B.65, IV.B.71, IV.B.74, IV.B.81, IV.B.87, IV.B.89. Conference presentations: IV.B.125, IV.B.127, IV.B.133, IV.B.136, IV.B.140, IV.B.143.

19. Sang-In Park Began advising Summer 2011. Passed Ph.D. Qualifiers: Spring 2013. Graduation: Fall 2016. Position: Assistant Professor, Incheon National University, South Korea
Dissertation Title: Estimating Mechanical Properties of Cellular Solid Materials from Additive Manufacturing Processes
Journal Publications: IV.B.1.72, IV.B.1.80, IV.B.85, IV.B.1.88, IV.B.1.91. Conference presentations: IV.B.148, IV.B.152, IV.B.154, IV.C.87, IV.C.90, IV.C.93, IV.D.23 (w/o proceedings).

20. Xiayun Zhao Began advising Spring 2014. Graduation: Spring 2017.
Position: Assistant Professor, University of Pittsburgh
Dissertation Title: Process Measurement and Control for Exposure Controlled Projection Lithography
Journal Publications: IV.B.84, IV.B.93, IV.B.94, IV.B.97, IV.B.102. Conference presentations: IV.B.149, IV.B.153, IV.B.156, IV.C.97, IV.C.99.

21. Chad Hume Began advising Fall 2010. Passed Ph.D. Qualifiers: Fall 2012. Graduated Spring 2022.
Position: Engineer, ChickfilA
Dissertation Title: Modeling of Material Jetting Additive Manufacturing with Applications to Paper Machine Fabrics
Conference Presentations: IV.D.3.23

22. Zhichao Wang Began advising Spring 2021. Passed Ph.D. Qualifiers: Spring 2020. Presented Ph.D. proposal in May 2022. Graduated Dec 2023.
Position: Software engineer, Salesforce.com

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Journal Publications: IV.B.135, IV.B.140, IV.B.142, IV.B.146, IV.B.148, IV.B.150
Conference presentations: IV.B.2.176

23. Yeming Xian Began advising Fall 2015 (co-adviser G. Paulino, 2020). Passed Ph.D. Qualifiers: Spring 2017. Presented Ph.D. proposal in December 2020. Graduation: Spring 2025.
Dissertation Title: Extensions of Topology Optimization for Additive Manufacturing
Journal Publications: IV.B.112. Conference presentations: IV.C.104, IV.C.112.
24. Janet Wong Began advising Fall 2021. Passed Ph.D. Qualifiers: Fall 2022. Graduation: Fall 2025.
Dissertation Title: Topology Optimization for Additively Manufactured Continuous Fiber-Reinforced Polymer Composites
Position: research engineer, DSO, Singapore
Journal Publications: IV.B.141, IV.B.158, IV.B.169. Book chapter: IV.A.2.15. Conference presentations: IV.C.1.131, IV.C.1.132, IV.D.1.36, IV.D.2.56, IV.D.3.33, IV.D.3.35.

In Process

1. Abdulmajeed Altassan Began advising Fall 2021. Passed Ph.D. Qualifiers: Fall 2022. Presented Ph.D. proposal in February 2026.
2. Xiaofang Liu Began advising Summer 2023.

2. M.S. Thesis Students

a) Graduated

1. Steven Hassenzahl Began advising during Summer 1992, graduated June 1994.
Thesis title: Extensions of CAD Representations to Support Configuration Design of Assemblies.
Position: NCR, Product Design Engineer.
Journal Publications: IV.B.9.
2. Stewart Coulter Began advising 9/92. Co-advisee with Bert Bras. Graduated 12/94.
Thesis title: Representation of Geometric Constraints in Parametric Synthesis.
Position: Research Engineer, Accenture.
Journal Publications: IV.B.11. Conference presentations: IV.B.16, IV.B.21.
3. Patrick Newcomb Began advising Fall 1993. Graduated 5/01. Co-advisee with Bert Bras.
Thesis Title: Implications of Modularity on Product Design for the Life Cycle.
Position: Research Scientist, Georgia Tech
Journal Publications: IV.B.9, IV.B.16. Conference presentations: IV.B.26.
4. Matthew Bauer Began advising during Fall 1994. Presented Thesis: 6/97. Graduation: 12/97.
Thesis Title: Integration of Product & Disassembly Process Design in Parametric Synthesis.
Position: Software Engineer, Alventive.
5. Zahed Siddique Began advising during Fall 1994. Graduated June 1996.
Thesis Title: Conversion of CAD Model Data for Virtual Prototypes for Disassembly.
6. Joel McClurkin Began advising Fall 1995. Graduated June 1997.
Thesis Title: A Computer-Aided Build Style Decision Support Method for Stereolithography.
Position: Design Engineer at Schlumberger.
Journal Publications: IV.B.15. Conference presentations: IV.C.5, IV.C.7.
7. Brian Harper Began advising Winter 1996. Graduated: June 1998.
Thesis Title: A CAD Environment for De- & Remanufacturing Assessments.
Position: Senior Engineer at MERC.
Journal Publications: IV.B.21. Conference presentations: IV.B.36, IV.B.42.
8. Charity Lynn Began advising Spring 1997. Graduated: September 1998.
Thesis Title: Accuracy Models for SLA Build Style Decision Support.

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Position: Manufacturing Engineer at Kimberley-Clark.
Journal Publications: IV.B.20. Conference presentations: IV.C.13, IV.C.14, IV.C.18.

9. Sundiata Jangha Began advising Spring 1997. Graduated: May 2002.
Thesis Title: An Ejection Mechanism Design Method for Rapid Injection Molding Tools.
Position: Ph.D. student at Georgia Tech.

10. Chris Franck Began advising Fall 1997. Graduated: 12/99.
Thesis Title: Assessing the Value of Rapid Prototyping and Tooling in Product Design Processes
Position: Design Engineer at Motorola.
Conference presentations: IV.B.50.

11. Aaron West Began advising Fall 1997. Graduated: 6/99.
Thesis Title: A Decision Support System for Fabrication Process Planning of Stereolithography.
Position: Design Engineer at Northrup-Grumman.
Journal Publications: IV.B.23. Conference presentations: IV.B.44, IV.C.13, IV.C.14, IV.C.19.

12. Alok Kataria Began advising Fall 1998. Graduated: 8/2000.
Thesis Title: Standardization and Process Planning for Building Around Inserts in SLA.
Position: Services Consultant at Velant, Inc. (ATDC start-up).
Journal Publications: IV.B.27. Conference presentations: IV.B.46, IV.B.51

13. Shiva Prasad Sambu Began advising Fall 1999. Graduated: 12/2001
Thesis Title: A Design for Manufacture Method for Rapid Prototyping and Rapid Tooling
Position: Manufacturing Engineer, Align Technology.
Journal Publications: IV.B.23, IV.B.31, IV.B.34. Conference presentations: IV.B.56, IV.B.62.

14. Hongqing Wang Began advising Fall 1999. Graduation: 12/2001
Thesis Title: Computer-Aided Design Methods for the Additive Fabrication of Truss Structures.

15. Brian Corbett Began advising Fall 2000. Graduation: 5/2003
Thesis Title: Configuration Design Methods and Mathematics for Product Families.
Position: Manufacturing Engineer, Bell Helicopter.
Journal Publications: IV.B.32. Conference presentations: IV.C.70.

16. Benay Sager Began advising Fall 2000. Graduation: 5/2003
Thesis Title: A Method for Understanding and Predicting SLA Resolution.

17. Christopher Williams Began advising Fall 2000 with Farrokh Mistree. Graduation: 12/2003.
Thesis Title: A Constructal Theory Approach to Product and Process Family Design.

18. Austina Nguyen Began advising Fall 2001. Graduation: 8/2004
Thesis Title: Design and Manufacture of Skins for Digital Clay Human-Computer Interface Devices.
Position: Engineer at Lexmark
Conference presentations: IV.B.68, IV.B.83, IV.C.42, IV.C.43.

19. Jae-Hyoung Park Began advising Fall 2001. Graduation: 5/2003
Thesis Title: Process Planning for Laser Chemical Vapor Deposition.
Position: Design Engineer, Samsung.
Conference presentations: IV.B.67, IV.B.71, IV.C.39.

20. Ameya Limaye Began advising Fall 2002. Graduation: 12/04
Thesis Title: Design and Analysis of a Mask Projection Micro-Stereolithography System.

21. Jamal Wilson Began advising Fall 2003. Graduation: 5/2006.
Thesis Title: Selection for Rapid Manufacturing under Epistemic Uncertainty.

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22. Lauren Margolin Began advising Fall 2004. Graduation: 12/2006
Thesis Title: Ultrasonic Droplet Generation Jetting Technology for Additive Manufacturing: An Initial Investigation
Position: Design engineer, Lutron.
Conference presentations: IV.D.58, IV.C.59.

23. Ted Anderson Began advising Spring 2006. Graduation: Spring 2007.
Thesis Title: Simulation and Fabrication of a Formable Surface for the Digital Clay Haptic Device
Position: Engineer, Marshall Space Flight Center.

24. Greg Graf Began advising Spring 2007. Graduation: Spring 2009
Thesis Title: Development of Specialized Base Primitives for Meso-Scale Conforming Truss Structures
Journal papers: IV.B.51, IV.B.53. Keynote: IV.D.1. Conference presentations: IV.B.104, IV.C.68.
Position: Engineer, Link Systems.

25. Jeff Olson Began advising Summer 2007. Graduation: Spring 2009
Thesis Title: Design and Modeling of a Portable Hemodialysis System.
Position: Product Development Engineer, Kids II.
Conference presentations: IV.C.72.

26. Sarah Engelbrecht Began advising Fall 2007. Graduation: Spring 2009.
Thesis Title: Design of Meso-Scale Cellular Structure for Rapid Manufacturing
Position: Design Engineer, Northrup-Grumman.
Journal papers: IV.B.53. Conference presentations: IV.B.104, IV.C.69, IV.C.70, IV.C.74.

27. Chen Chu Began advising Fall 2007. Graduation: Summer 2009.
Thesis Title: Design Synthesis for Morphing 3D Meso-scale Structure
Position: Design Engineer, Michelin.
Journal papers: IV.B.51, IV.B.53. Keynote: IV.D.1. Conference presentations: IV.B.104, IV.C.68.

28. Xiayun Zhao Began advising Spring 2008. Graduation: Spring 2009.
Thesis Title: Process Planning for Thick-Film Mask Projection Micro Stereolithography
Position: Ph.D. student at GT.
Conference presentations: IV.B.101, IV.B.107.

29. Patrick Chang Began advising Fall 2008. Graduated: Fall 2011.
Thesis Title: An Improved Size, Matching, and Scaling Method for the Design of Deterministic Mesoscale Truss Structures
Position: Design engineer, Nikon Research.
Journal Papers: IV.B.62. Conference presentations: IV.B.106, IV.B.114, IV.B.121.

30. Jane Kang Began advising Fall 2008. Graduated: Spring 2010.
Thesis Title: Pump Design for a Portable Renal Replacement System
Position: Ph.D. student at GT
Conference presentations: IV.C.72.

31. Jason Nguyen Began advising Fall 2010. Graduated: Summer 2012.
Thesis Title: A Heuristic Optimization Method for the Design of Meso-Scale Truss Structure for Complex-Shaped Parts
Position: Design engineer, BP
Journal Publications: IV.B.72. Conference presentations: IV.C.87, IV.C.90, IV.C.93.

32. Chad Hume Began advising Fall 2010. Graduated: Fall 2013.
Thesis Title: Platform Variability Identification using Sensitivity Analysis for Product Platform Design
Position: Ph.D. student, GT
Conference Presentations: IV.B.130.

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33. Narumi Watanabe Began advising Fall 2014. Graduated: Fall 2016.
Thesis Title: Computational and Experimental Investigation of Reinforced Polymers for Material Extrusion Additive Manufacturing
Position: design engineer, Boeing
Conference presentations: IV.C.1.102, IV.D.3.23

34. Ying Zhang Began advising Fall 2014; co-advised with Amit Jariwala. Graduated: Fall 2016.
Thesis Title: Empirical Process Planning for Exposure Controlled Projection Lithography
Position: graduate student at Univ. Toronto
Conference presentations: IV.C.1.101, IV.D.3.23

35. Changxuan Zhao Began advising Spring 2015; co-advised with Amit Jariwala. Graduated: Summer 2017.
Thesis Title: Real-Time Monitoring of Exposure Controlled Projection Lithography (ECPL) Process
Position: PhD student at Georgia Tech.
Conference presentations: IV.B.2.155, IV.B.2.156

36. John-Travis Hansen Began advising Fall 2015. Graduated: Fall 2017.
Thesis Title: Empirical Process Planning for Exposure Controlled Projection Lithography
Position: mechanical designer,
Journal Publications: IV.B.1.103. Conference presentations: IV.B.2.167

37. Nicholas Mulka Began advising Fall 2020. Graduated: May 2022. Co-advised with Amit Jariwala.
Thesis Title: Fluid Interface Supported Printing for Three-Dimensional Object Fabrication
Position: unknown
Conference presentations: IV.C.1.125

b) In Process
N/A

M.S. Special Problems students.

1. Dan Ganser 1993 Recognition of Machinable Volumes from a Part CSG Tree for Automated NC Programming.
2. Dainelle Swann 1993 Tool Design Considerations from Feature-based Component Design for Vacuum Forming.
3. M. C. Ramesh 1996 Surface Fitting to Point Cloud Data
4. Kevin Kamphuis 1996 Robust Rapid Tooling for Injection Molding
5. Imran Yusuf 1996 Rapid Tooling: ACES Injection Molding
6. Brian VanHeil 1997 Alternative Ejection Methods for Rapid Tooling
7. E. Kenneth Escoe 1999 A Working Database for the Rapid Tooling Testbed
8. Paul Lowe 2001 Toward Restorative Dentistry through Mechanical CAD and Rapid Prototyping
9. John Edie 2003 Work Environment Plan to Support Design of Machinery for Closure Molding
10. Loren Ybbarando 2003 A Learning Environment for Computer-Aided Design
11. Kevin Au 2005 Applying Rapid Manufacturing Technologies to Fabricate Space Based Solar Array Substrates
12. Abeera Sohail 2013 Vibration Characteristics of AM-Fabricated Lattice Structures
13. Hamed Ammar, 2019 Determining Manufacturability using Machine Learning/AI

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3. Service on Thesis or Dissertation Committees

a) Internal

Grad. Year	Degree	Student	School or College
1998	Ph.D.	Stewart Coulter, Timothy Simpson	GWW School
	Masters	Andre Claudet, Uma Sankar, Roberto Ortega, Greg Mumpower, Gabrial Hernandez	GWW School
	Masters	Kent Dawson	ChE
1999	Ph.D.	Elizabeth Judson	MSE
	Masters	Amy Herrmann, Scott McDermott	GWW School
	Masters	James Hemrick	MSE
2000	Ph.D.	Thomas Tucker	GWW School
	Masters	Chad Moore, Bradley Geving, Brian Fuhrman, Ruben Lanz	GWW School
2001	Ph.D.	Andre Claudet, Dan Jean, Chad Duty, Gabriel Hernandez	GWW School
	Ph.D.	Kenneth Dawson	Chem. Engr.
	Ph.D.	Joon Park	Management
	Masters	Haejin Choi, Carolyn Conner-Seepersad, Brian Davis, Jacob Diez, Rahul Kulkarni, Xavier Ottemer, Angela Tse	GWW School
2002	Ph.D.	Carolyn Conner-Seepersad	GWW School
	Masters	Matthew Chamberlain, Marco Fernandez, Yanyan Tang, Tosin, Tomori	GWW School
2003	Ph.D.	Angran Xiao	GWW School
	Masters	Paul Bosscher, Michael Carone, Samuel Dessolin, Casey McIntosh, Megan Shilling	GWW School
2004	Ph.D.	Myong Kee Jeong	ISyE
	Ph.D.	Yao Lin, James Nichols	GWW School
2005	Ph.D.	Yanyan Tang	ChBE
	Ph.D.	Hae-Jin Choi, Marco Fernandez, Jitesh Panchal, Haihung Zhu	GWW School
	Masters	Tim Ernst, Rakesh Kulkarni	GWW School
2006	Masters	Bert Bradley, Davis Garth	GWW School
2007	Ph.D.	Benita Comeau	ChBE
	Ph.D.	Matt Chamberlain	GWW School
	Masters	Gautam Jadhav	GWW School
2008	Masters	Kenway Chen, Jiten Patel	GWW School
2010	Ph.D.	Stephanie Thompson, Siddarth Athreya	GWW School
	Ph.D.	Matthew Simons	Aero Engr.
2011	Masters	Sean Tessier	GWW School
2012	Ph.D.	Nate Sirirojvisuth	AE
	Masters	Edin Crnic	GWW School
2013	Ph.D.	Anirudh Rudraraju	GWW School
2014	Ph.D.	Wei Huang	GWW School
	Masters	Mahmoud Alzahrani, Recep Gorguluarslan	GWW School
2016	Ph.D.	Recep Gorguluarslan, Masoumeh Aminzadeh	GWW School
2018	Ph.D.	Jiangtao Wu	GWW School
	Ph.D.	Emily Fitzharris	MSE
2019	Masters	Richard Nwaeri	GWW School
2020	Ph.D.	Hyeonik Song	GWW School
	Ph.D.	Ricardo Bonilla-Alicea	GWW School
	Ph.D.	Oliver Giraldo Londono	CEE
2021	Ph.D.	Hyeonik Song	GWW School
2021	Ph.D.	Alexander Murphy	GWW School

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2021	Ph.D.	Bumsoo Lee	GWW School
2021	Ph.D.	Tuo Zhao	CEE
2021	Masters	Emily Alcazar	CEE
2022	Ph.D.	Elliott Jost	GWW School
2022	Ph.D.	Changxuan Zhao	GWW School
2024	Ph.D.	Xiaoliang Yan	GWW School
2025	Masters	Jaime Maqueda	GWW School

b) External

Grad. Year	Degree	Student	School or College
2000	Masters	Michael Pearson	University of Louisville, Chemical Engineering
2003	Ph.D.	Yang Yong	Nat'l Univ. of Singapore
	Ph.D.	Naguib Saleh	Loughborough Univ, UK
2011	Ph.D.	David Brackett	Loughborough Univ., UK
2012	Ph.D.	Martin Baumers	Loughborough Univ., UK
2015	Ph.D.	Ningrong Lei	MAE, Nanyang Tech. U (Singapore)
2016	Ph.D.	Athena Jalalian	Nat'l Univ. Singapore
	Ph.D.	Samyeon Kim	Nanyang Tech U
2017	Ph.D.	Pekka Lehtinen	Aalto Univ, Finland
	M.S.	Shahrain Bin Mahmood	Newcastle Univ, Singapore
2018	Ph.D.	Hyunwoong Ko	MAE, Nanyang Tech. U (Singapore)
2019	Ph.D.	Enea Sacco	MAE, Nanyang Tech. U. (Singapore)
2020	Ph.D.	Davide Redaelli	Polytecnico di Milano (Italy)
2021	Ph.D.	Aprilia	MEA, Nanyang Tech. U. (Singapore)
2021	Ph.D.	James Alum	Loughborough Univ, UK
2022	Ph.D.	Jan Akmal	Aalto Univ., Finland
2024	Ph.D.	Aliaksei Petsiuk	Western Univ, Canada
2024	Ph.D.	Chonghui Zhang	McGill Univ, Canada

4. Mentorship of Postdoctoral Fellows and Visiting Scholars

Post-Doctoral Students supervised.

1. Scott Johnston Advised: Sept. 2005 to Sept 2006.
   Conference Presentations: IV.B.90, IV.D.60, IV.D.61, IV.D.62, IV.D.13 (w/o proceedings).
2. Sanjay Vohra Advised: May 2007 - May 2008.
   Conference Presentations: IV.B.100.
3. Yong Yang Advised: June 2007 – June 2009.
   Journal Publications: IV.B.56. Conference Publications: IV.D.72, IV.D.76, IV.D.17 (w/o proceedings).
4. Fei Ding Advised: August 2007 – Aug. 2010.
   Journal Publications: IV.B.60. Conference Presentations: IV.B.101., IV.B.107., IV.B.110, IV.D.81.
5. J. Mark Meacham Advised: September – December 2008
   Journal Publications: IV.B.57. Conference Publications: IV.D.76, IV.D.17 (w/o proceedings).
6. Mahmoud Dinar Advised: December 2015 – May 2016
7. Sang-In Park Advised: November 2016 - May 2017

At SUTD

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8. Mahdi Emami Advised: Jan 2017 – Dec. 2019
9. Samyeon Kim Advised: May 2017 – Aug. 2020
10. Vahid Hassani Advised: June 2017 – February 2019
11. Sang-In Park Advised: July 2017 – February 2019
12. Yi Xiong Advised: October 2017 – April 2020
13. Yunlong Tang Advised: October 2018 – Feb. 2020
14. Narasimha Boddeti Advised: January 2018 – December 2019
15. Zhiyuan Zhang Advised: May 2018 – Sept. 2020
16. Fangfang Wang Advised: June 2019 – Feb. 2020
17. Chao Yuan Advised: June 2019 – Sept. 2020
18. Jingchao Jiang Advised: Sept. 2019 – July 2020
19. Guoying Dong Advised: Nov. 2019 – present
20. Mostafa Jamshidian Advised: January 2020 – July 2020
21. Yangfan Li Advised: 2021
22. Do Quang Huy Advised: 2022-2023

Visiting Scholars supervised.

1. Wenzheng Wu, Ph.D. student at Northwestern University, China. Advised Sept 2009 - Oct. 2010.
   Journal Papers: IV.B.64. Conference Presentations: IV.B.112, IV.B.123, IV.D.78.
2. Xijuan Liu, Associate Professor, Shanghai Dianji University. Visited Jan 2010 - Jan 2011.
   Conference Presentations: IV.B.109, IV.B.115.
3. Ningrong Lei, Ph.D. student at Nanyang Technological University, Singapore. Advised Sept. – Dec. 2014.
4. Marco Rossoni, Ph.D. student at Polytecnico di Milano, Milan, Italy. Advised Jan. - June 2019.
5. Mingeon Kim, Ph.D. student at Chung-Ang University, Korea. Advised Oct. 2021-March 2022.
6. Hyewon Shim, Ph.D. student at Sungkyungkwan University, Korea. Advised Oct. 2021-March 2022.

C. Other Teaching Activities

1. Course Development

1. Developed ME 6176, Computer-Aided Design Systems, as a course on the role of prototyping in engineering design, enabled by the usage of CAD and information technology. Course modules were developed on design process modeling, rapid prototyping technologies and their selection, virtual prototyping, and data handling for rapid prototyping. In 1996, a quarter-long design project was organized in conjunction with Siemens Residential Products Division. In 1998, a 3 week course module on rapid prototyping process planning was added.
2. Created, developed, and taught ME 7227 – Rapid Prototyping in Engineering in 2000. About half of the course material was a result of RPMI research. 15 students took the course from several research areas within the GWW School. In 2004, the course was revised and redeveloped to enable internet-based delivery through the GT Distance Learning program. Offered again in 2006. Course material formed the foundation for a new textbook on additive manufacturing (see IV.A.1).
3. Created a new interdisciplinary design course, ME4803, along with Sabir Khan (Arch, ID) and Alexandra Mazalek (LCC). Taught the course in Spring 2012, Spring 2013, Fall 2013, and Fall 2015. In the 2013 offerings, course modules were developed on CAD, 3D printing, and design

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processes. Projects were exhibited in the TechArts Festival (Spring), the GT Mini-Maker Faire (Fall), and Capstone Expo (Spring and Fall).

2. Course Improvement

1. Developed a three week module on solid modeling for ME 6175, Fundamentals of Computer-Aided Design in 1993 and 1994. Also developed a two week module on rapid prototyping, emphasizing the issues involved in automating the CAD-to-RP transfer in 1996.
2. Developed and delivered a companion lab course for ME 3110 (with Janet Allen and Farrokh Mistree) to test the efficacy of computer-based collaboration in a design course. Ran the lab as an optional Special Problems course (ME 4901). This activity was part of the funded EduTech project (VI.A.1). 1994-5.
3. Developed course materials and video-taped lectures to enable offering ME 6104 – Fundamentals of Computer-Aided Design, as an "internet course," during Fall 2001. To date, ME 6104 has been offered via the internet every year starting in Spring 2002.

3. Professional Development/Continuing Education

1. Developed a 2-day Technical Presentation (through GT's Continuing Education) entitled "Design for Recycling" with Dr. Bert Bras and delivered at General Motors, July 31-Aug. 1, 1995.

VI. SERVICE

A. Professional Contributions

1. Editorial Board Memberships

1. Co-editor for a special issue (Vol. 5, No. 3/4, 1993) of the journal Research in Engineering Design. Special Issue is entitled: "Advances in Representations and Reasoning for Mechanical CAD."
2. Associate Editor, *ASME J. of Computing and Information Science in Engineering*, 2000 – 2006.
3. Co-editor for special issue (Vol. 4, No. 1, March 2004) of the *ASME J. of Computing and Information Science in Engineering* entitled "Computer-Aided Conceptual Design." Co-editor is Imre Horvath.
4. Member, Editorial Board, *Biofabrication Journal*, 2008 - 2011.
5. Member, Editorial Board, *Rapid Prototyping Journal*, 2008 – present.
6. Member, Editorial Board, *Int'l J. of Precision Engineering and Manufacturing*, 2011 - 2018.
7. Member, Editorial Board, ASME Advances in Computers and Information in Engineering Research book series, 2012 – 2020.
8. Member, Editorial Board, *Additive Manufacturing*, 2014 – present.
9. Member, Editorial Board, *Additive Manufacturing and 3D Printing*, 2014.
10. Co-editor, special issue of *ASME Journal of Mechanical Design* on Design for Additive Manufacturing. Co-editors: C. Seepersad, T. Simpson, C. Williams. 2015
11. Member, Advisory Board, *Journal of Engineering Design*, 2022-present.
12. Member, Editorial Board, *4D Printing Journal*, 2024-present.
13. Member, Editorial Board, *Int'l J. of Precision Engineering and Manufacturing-Smart Technology*, 2024-present.

2. Society Offices, Activities, and Membership

1. Fellow, American Society of Mechanical Engineers, 2003. Member, 1985 – present.
2. Member, American Society of Engineering Educators, 1993 – 2005; 2009-present.
3. Member, Society of Manufacturing Engineers, 1996 – 2013.

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4. Member, Executive Committee of the Computers in Engineering Division of ASME, 1996-2002.
5. Lead, Lattice Structures Task Group, ASTM F-42 Standards for Additive Manufacturing, 2010-2012.
6. Chair, Design Subcommittee, ASTM F-42 Standards for Additive Manufacturing, 2012-present.
7. Fellow, ASTM International, 2022

3. Organization and Chairmanship of Technical Sessions, Workshops, and Conferences

1. Co-Chair, 4th ACM Siggraph Symp. On Solid Modeling and Applications. Atlanta, May 14-16, 1997.
2. Chair and Organizer for AI/Features Technical Area of the ASME Computers in Engineering Conference, 1997. Reviews were organized for 14 papers, sessions organized, and best paper selected.
3. Technical Program Chair for ASME Computers in Engineering Conference, Atlanta, 1998.
4. Organizer of special sessions on rapid prototyping in the ASME CIE, Design For Manufacturing, and Design Automation Conferences, 2000.
5. Host and Organizer, Advanced Rapid Prototyping & Manufacturing 2000 Symposium and Expo. Georgia Tech. Feb. 7-8, 2000.
6. Session organizer for "Representations, Optimization, and Simulation in Product Development" for the second Gordon Conference on Theoretical Foundations for Product Design and Manufacturing, June 11-16, 2000, Plymouth, NH.
7. Chair for the Computer-Aided Product Development Technical Committee of the ASME CIE Division. Organized reviews of 20 papers. 2001.
8. Host and Organizer, Society of Manufacturing Engineers Technology Forum on Mass Customization Enabled by Rapid Technologies. Georgia Tech. August 13, 2002.
9. Conference Chair, ASME Computers and Information in Engineering Conference, 2002.
10. Host and Organizer, Advanced Rapid Prototyping & Manufacturing 2002 Symposium and Expo. Georgia Tech. Oct. 9-10, 2002.
11. Chair, ASME Computers and Information in Engineering Division, 2001-2.
12. Chair, ASME CIE Computer-Aided Product Development Technical Comm., 2004.
13. Co-chair, Panel on Object Modeling, ASME CIE Conference, 2005.
14. Co-Chair, DARPA/ISAT Workshop on Rethinking CAD, Arlington, VA, Oct. 24-25, 2013.
15. Co-Chair, Digital Manufacturing and Design Centre Symposium, Singapore, Sept 1-3, 2020.
16. Chair, 4D Materials Design and AM Conference, Singapore, July 8-10, 2025.
    4D Materials Design and AM Workshop, Singapore, July 11, 2025.
17. Chair, NAMIC Global AM Summit, Panel session on: Panel: From Design to Delivery: Building a Seamless Digital Thread, 16 Oct, 2025.

4. Technical Journal or Conference Referee Activities

11. *Reviewer, 2024 for (20 Total): ASME J. of Mechanical Design, Additive Manufacturing, Additive Manufacturing Letters, Int'l J. Mechanical Sciences, Composites Part B, Computers in Industry, Int'l J Computer Integrated Manufacturing, Materials and Design, Virtual and Physical Prototyping, Journal of Intelligent Manufacturing, CIRP J. Manufacturing Science and Technology, J Computational Design and Engineering*
12. *Reviewer, 2025 for (20 Total): ASME J. of Mechanical Design, Additive Manufacturing, Additive Manufacturing Letters, Int'l J. Mechanical Sciences, Composites Part B, Computers in Industry, Int'l J Computer Integrated Manufacturing, Materials and Design, Virtual and Physical Prototyping, Journal of Intelligent Manufacturing, CIRP J. Manufacturing Science and*

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Technology, J Computational Design and Engineering, Computer Methods in Applied Mechanics and Engineering

5. Proposal Panels and Reviews

1. Panel reviewer of eight proposals at NSF (Arlington, VA) in April 1997.
2. Reviewer in 1998: 3 mailed proposals, Panel in June
3. Reviewer in 1999: Panel in June
4. Reviewer in 2000: Panel in December
5. Reviewer in 2002: Panel in May, Panel in November
6. Reviewer in 2004: Panel in December
7. Reviewer in 2007: Panel in May
8. Reviewer in 2009: Panel in November
9. Reviewer in 2011: Panel in May
10. Reviewer in 2013: Panel in May
11. Reviewer in 2014: Panel in May, Panel in September
12. Reviewer in 2015: Panel in October
13. Ad hoc reviewer for NSF in 2022: 3 proposals

6. Other Involvement

1. Member, Program Committee, Euro RP 2001 – European Conference on Rapid Prototyping & Manufacturing, Paris, France, June 7-8, 2001.
2. Member, WTEC Panel on Assessment of European Research and Development in Additive/Subtractive Manufacturing, Site visits to European research centers, Oct. 19-25, 2003.
3. Member, Program Committee, EcoDesign 2003, 3rd International Symposium on Environmentally Conscious Design and Inverse Manufacturing, Dec. 8-11, 2003, Tokyo, Japan.
4. Member, Program Committee, International Symposium on Tools and Methods of Competitive Engineering (TMCE), 1998 – 2006.
5. Member, Program Committee, Euro RP 2004 – European Forum on Rapid Prototyping, Paris, Sept. 14-15, 2004.
6. Member, Advisory Board, CAD'05, Bangkok, Thailand, June 20-24, 2005.
7. Member, Advisory Board, CAD'06, Phuket, Thailand, June 19-23, 2006.
8. Member, Advisory Committee, SFF Symposium, Austin, TX, Aug. 2006-present.
9. Member, Advisory Board, CAD'07, Honolulu, Hawaii, June 25-29, 2007.
10. Member, Program Committee, Int'l Conf. on Manufacturing and Automation, Singapore, May 28-30, 2007.
11. Member, Scientific Committee, Virtual and Rapid Prototyping Conferences, Leiria, Portugal, 2007 - 2013. Manchester, UK, 2015.
12. Member, International Program Committee, International Conference on Manufacturing and Automation, Hong Kong, Dec. 13-15, 2010.
13. Member, Advisory Committee, Int. Symposium on Green Manufacturing and Applications, Jeju, Korea, Aug 27-29, 2012.
14. Member, International Programme Committee, 5th International Conference on Research into Design (ICoRD'15), Bangalore, India, 2013-2015.
15. Member, ICED13 Scientific Committee, Int'l Conference on Engineering Design, Seoul, Korea, Aug 19-22, 2013.
16. Member, ICED15 Scientific Committee, Int'l Conference on Engineering Design, Milan, Italy, July 27-30, 2015.

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17. Member, ICED17 Scientific Committee, Int'l Conference on Engineering Design, Vancouver, Canada, Aug 21-25, 2017.
18. Member, ASME Additive Manufacturing & 3D Printing (AM3D) Conference organizing committee, Boston, Aug 2-5, 2015.
19. Member, ASME Additive Manufacturing & 3D Printing (AM3D) Conference organizing committee, Charlotte, Aug 21-24, 2016.
20. Member, ICIDM17, Steering Committee, Int'l Conference on Innovative Design and Manufacturing, Milan, Italy, July 17-19, 2017.
21. Member, ICEI2018, Advisory Board, Int'l Conference on Engineering Innovation, Bangkok, Thailand, July 5-6, 2018.
22. Member, Scientific Committee, CIRP Design Conference, Nantes, France, May 23-25, 2018.
23. Member, Scientific Committee, Progress in Additive Manufacturing (Pro-AM) Conference, Singapore, May 14-17, 2018.
24. Member, Modular and Offsite Construction Conference scientific committee, Banff, Alberta, Canada, May 21-24, 2019.
25. Member, Scientific Committee, Progress in Digital and Physical Manufacturing (ProDPM'19), Leiria, Portugal, Oct 2-4, 2019.
26. Member, Scientific Committee, International Conference on Research Advances in Additive Manufacturing, Nanjing, China, March, 2019, 2020.
27. Member, Scientific Advisory Board, International Conference on Computational Design and Engineering, Kuala Lumpur, Malaysia, June 28-30, 2020.
28. Member, Scientific Committee, Second International Conference on Progress in Digital and Physical Manufacturing, Leiria, Portugal, Oct 13-15, 2021.
29. Member, International Scientific Committee, Design for Additive Manufacturing Conference, Singapore, May 19-20, 2022.
30. Member, International Conference on Additive Manufacturing for a Better World, Singapore, August 23-25, 2022.
31. Member, International Scientific Advisory Committee, International Conference on Computational & Experimental Engineering and Sciences, Singapore, August 2-6, 2024.
32. Member, Program Committee, Asia Design Innovation Conference, Shanghai, Dec. 5-6, 2024.
33. Member, International Scientific Committee, International Conference on Future of Additive Manufacturing, Singapore, August 5-7, 2025.

Book Reviews

1. Reviewed proposal for *Geometric Modeling for Engineers*, D. Ryan, CRC Press, January 2003.
2. Reviewed textbook: *Rapid Prototyping: Principles and Applications*, R. Noorani, Oxford University Press, January 2003.

Corporate Boards

1. Member, Advisory Board, Helio Additive Information Technology Co, Changshu, China, 2020-2024.

B. Georgia Institute of Technology Contributions

1. Member, Faculty Recruiting Committee, GWW School of Mechanical Engineering, 2000-05.
2. Member, Faculty Advisory Committee, GWW School of Mechanical Engineering, 2001 – 2003.
3. Chair, Faculty Recruiting Committee, GWW School of Mechanical Engineering, 2003-4.
4. Member, Graduate Committee, GWW School of Mechanical Engineering, 2004-5.
5. Member, Periodic Peer Review Committee, GWW School of Mechanical Engineering, 2004-5.

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6. Member, Ad Hoc Graduate Math Committee, GWW School of Mechanical Engineering, 2004-5.
7. Member, Ad Hoc Research Retreat Committee, GWW School of Mechanical Engineering, 2004-5.
8. Chair, Graduate Committee, GWW School of Mechanical Engineering, 2005-6.
9. Chair, GWW Savannah Recruiting Committee, GWW School of Mechanical Engineering, 2005-7.
10. Member, GWW Savannah Advisory Committee, GWW School of Mechanical Engineering, 2005-6.
11. Member, GT Academic Senate, 2005-7.
12. Member, GT Institute Graduate Curriculum Committee, 2008-11.
13. Member, GT Oliver Professor of Practice Search Committee, 2009-10.
14. Member, GWW Ad Hoc Committee on Teaching Loads, 2010.
15. Chair, GWW Ad Hoc Search Committee for Director - Financial Services & Administration, 2011.
16. Chair, GWW Ad Hoc Search Committee for Director of Design & Innovation, 2012.
17. Chair, GWW Ad Hoc Search Committee for Machine Shop Supervisor, 2012.
18. Member, GWW Reappointment, Promotion, Tenure Committee, 2012-15.
19. Chair, GWW Ad Hoc Committee on Design Position Responsibilities, 2013.
20. Chair, GWW Ad Hoc committee on Design and Fabrication Studio, 2014-15.
21. Chair, GWW Ad Hoc Search Committee for ME1770 Academic Professional, 2015.
22. Member, GWW Undergraduate Committee, 2018-19.
23. Chair, GWW Periodic Peer Review committee, 2019.
24. Member, GWW Graduate Committee, 2019-2022.
25. Co-Chair, GWW ad hoc committee on PhD Qualifying Exams, 2019-2020.
26. Chair, GWW Reappointment, Promotion, Tenure Committee, 2020-2022.
27. Member, GWW ad hoc committee on PhD Qualifying Exam Implementation, 2020-21.

1. Program Development: Research

Director, Rapid Prototyping and Manufacturing Institute, 1995 – present. Responsibilities include soliciting faculty involvement, formulating educational and research programs, directing the research program, supervising student projects, and coordinating operations of the laboratory with other stakeholders. Nine other faculty from 3 Schools (ME, ChE, Mgmt) have conducted research funded by the RPMI. Many others utilize the RPMI equipment and facilities in support of their research.

Between 5 and 14 companies have been members of the RPMI, contributing between $130K and $280K in funds and in-kind donations. Dr. Rosen directs the allocation of these funds.

ADDITIONAL INFORMATION

Significant Industry Gifts to Dr. Rosen in Support of Research

1. AT&T, $4000, November, 1995.
2. Ford Motor Company, $9000, July 1997.
3. Ford Motor Company, $10,000, February 1998.
4. Ford Motor Company, $15,000, June 1998.
5. Ford Motor Company, $10,000, January 2000.
6. Albany International, $17,000, November 2007.

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7. Albany International, $20,000, June 2008.
8. Albany International, $20,000, April 2009.

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