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The Limits of Creativity in Copyright: Digital Manufacturing Files and Lockout Codes

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The Limits of Creativity in Copyright: Digital Manufacturing Files and Lockout Codes

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Abstract

As the distinction between the digital and physical worlds continues to diminish, the necessity to reevaluate the bargain struck by the copyright regime increases in importance. Digitization brings increasingly more aspects of our world into the potential ambit of the copyright system. To understand whether and how the copyright system should apply in an increasingly digital world, it is first necessary to understand doctrinally how current copyright laws apply to new digital works. This Article corrects several errors that have appeared in the literature analyzing copyright law's treatment of 3D printing and other digital manufacturing files. This Article incorporates an advanced technical understanding of digital manufacturing files and applies that understanding to copyright doctrine to clarify misunderstandings. The analysis briefly confirms that digital files created to manufacture creative objects are themselves clearly protected by copyright. On the other hand, and contrary to several assertions in the literature, most files created to manufacture purely utilitarian objects are not copyrightable because they lack a modicum of creativity. The lack of copyright protection for these files calls into question a number of assumptions, including whether they can be protected against even verbatim copying and whether open-source licenses involving these files can efficaciously bind downstream users. If digital manufacturing files of purely utilitarian objects do not enjoy copyright protection, creators may seek to embed additional, ancillary copyrightable material in the files to secure protection. This ancillary material serves as a lock-out code, which tries to prevent what would otherwise be lawful copying. This Article analyzes that phenomenon and discusses potential ways the law may react to it.

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I. INTRODUCTION

The distinction between the digital and physical worlds continues to diminish. This digitization phenomenon affects society in myriad ways, and potentially brings the copyright regime to bear on technology previously outside its realm. For example, purely utilitarian physical objects have long stood outside of the copyright regime, but as three-dimensional printing (3D printing) and other technologies digitize physical objects, the copyright system might apply to the digital versions of these objects. Whether this is a desirable development from an incentive-to-create-and-disseminate theory, which is the dominant theory behind the United States' copyright system, deserves careful analysis. The first steps in the analysis include understanding current digital technologies and how the current copyright system applies to these technologies as a matter of doctrine and theory. This Article accomplishes these initial steps.

Much ink has been spilled analyzing the exciting potential of 3D printing[1] (sometimes called additive manufacturing or rapid prototyping), including how it will interact with the law.[2] But 3D printing is not

1. *See generally* CHRIS ANDERSON, MAKERS: THE NEW INDUSTRIAL REVOLUTION (2012); HOD LIPSON & MELBA KURMAN, FABRICATED: THE NEW WORLD OF 3D PRINTING (2013); Lucas S. Osborn, *Regulating Three-Dimensional Printing: The Converging Worlds of Bits and Atoms*, 51 SAN DIEGO L. REV. 553 (2014); *Special Report: Manufacturing and Innovation: A Third Industrial Revolution*, THE ECONOMIST (Apr. 21, 2012), http://www.economist.com/node/21552901 [https://perma.cc/3XH3-6ZWG] [hereinafter *A Third Industrial Revolution*].

2. *See generally* Michael Weinberg, *What's the Deal with Copyright and 3D Printing?*, PUBLIC KNOWLEDGE (Jan. 29, 2013), https://www.publicknowledge.org/files/What's%20the%20Deal%20with%20Copyright_%20Final%20version2.pdf [https://perma.cc/U6XY-WLXC]; Michael Weinberg, *It Will Be Awesome If They Don't*

the only digital manufacturing technology causing stress on intellectual property law's fault lines. Computer numerically controlled ("CNC") manufacturing and laser cutting are also making headlines as they proliferate and migrate from purely business applications into individual's homes.[3]

In the field of intellectual property law, attention correctly focuses on the treatment of the digital files that contain the instructions (one might say, recipes) used by the digital manufacturing devices. Section II of this Article describes these files in more detail.

Because users can easily copy and distribute these files across the internet, many who create them will want to control them. Intellectual property law is one obvious avenue for control, notably copyright law and patent law. Of course, other means of appropriability exist, including lead time advantage, contract, and technological protection measures. But of all potential control mechanisms for digital manufacturing files, copyright law has received the most attention.

Unfortunately, the literature regarding copyright and digital manufacturing files is inexact, confused at times, and often simply wrong. The issue is not one merely of fastidious attention to academic minutia. The confusion unnecessarily complicates the analysis and leads to multiple errors. First, the literature's laxity obscures the fact that one must analyze files in terms of the copyright statute's terminology; that is, in terms of the work(s) they embody. A digital manufacturing file is not a "work" under the statute. A given manufacturing file may, however, embody one or more of at least the following: a sculptural work, a pictorial/graphic work, a literary work, and an architectural work.[4] In addition, files stored on computer media can constitute "copies" of the work.[5] Thus, to determine whether copying a digital file constitutes infringement, one must separately analyze each category of work that the file might embody.

A second confusion is that some consider digital manufacturing files to be, in the copyright statute's vernacular, "useful articles." They are not. The useful articles exception applies when the *underlying work* (not the file, which is a copy), such as a sculptural work, is a utilitarian object.[6]

Screw It Up: 3D Printing, Intellectual Property, and the Fight Over the Next Great Disruptive Technology, PUBLIC KNOWLEDGE (Nov. 2010), https://www.publicknowledge.org/files/docs/3DPrintingPaperPublicKnowledge.pdf [https://perma.cc/RC5W-3VDY].

3. *See the Future, Manufacturing in Every Home*, CNC REPORT.COM (Sept. 21, 2011), http://www.cncreport.com/home-manufacturing/ [https://perma.cc/4MQN-BGMR] [hereinafter *See the Future*].

4. *See* 17 U.S.C. § 101 (2017) (defining these categories of works); *infra* Section III.A.

5. 17 U.S.C. § 101 (defining "copies").

6. *See infra* Section III.B.

The above-mentioned confusions are addressed in Section III of this Article. In Section IV, this Article resolves confusion regarding copyright law's treatment of digital manufacturing files that will manufacture purely utilitarian objects.[7] The analysis does not focus on the copyrightablility of the underlying physical object; a purely utilitarian object clearly enjoys no copyright protection. This Article also does not engage in questions about physical objects with a mixture of utilitarian and creative aspects. Rather, this Article focuses on the digital files that will assist in the manufacture of a purely utilitarian physical object.

The existing literature perpetuates an erroneous analysis of these files, syllogistically suggesting that, because they are (or are like) technical drawings or literary works, they ipso facto enjoy copyright protection. This simplistic analysis ignores the Supreme Court's elaboration of a constitutional requirement that works must contain a modicum of creativity to be eligible for copyright protection.[8] This confusion may arise in part because many digital files, such as movies and songs, embody clearly creative works. It may also arise from courts' persistently unanalytical treatment of virtually all software applications as copyrightable. Section IV thus engages with the theory and doctrine relevant to software copyrights[9] and "low-authorship" works.[10] It also provides an avenue to consider these files as residing in an IP-negative space.[11]

Regardless of the confusion's origins, this Article dispels the confusion by demonstrating a lack of meaningful creativity in many—if not all of—these files.[12] This analysis rebuts the existing literature, and the consequences are pervasive. For instance, entire articles constructing

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7. Such files may be protectable by patent law, but that is not the focus of this Article. By focusing on files of purely utilitarian objects, Section IV will not discuss copyright or design patent protections for ornamental or creative works.

8. Feist Publ'ns, Inc. v. Rural Tel. Serv. Co., 499 U.S. 340, 346 (1991).

9. *See, e.g.*, Peter S. Menell, *Tailoring Legal Protection for Computer Software*, 39 STAN. L. REV. 1329 (1987); J.H. Reichman, *Computer Programs as Applied Scientific Know-How: Implications of Copyright Protection for Commercialized University Research*, 42 VAND. L. REV. 639 (1989); A. Samuel Oddi, *An Uneasier Case for Copyright Than for Patent Protection of Computer Programs*, 72 NEB. L. REV. 351 (1993); Pamela Samuelson et al., *A Manifesto Concerning the Legal Protection of Computer Programs*, 94 COLUM. L. REV. 2308 (1994); Pamela Samuelson, *The Uneasy Case for Software Copyrights Revisited*, 79 GEO. WASH. L. REV. 1746 (2011).

10. *See, e.g.*, Jane C. Ginsberg, *Creation and Commercial Value: Copyright Protection of Works of Information*, 90 COLUM. L. Rev. 1865 (1990); Justin Hughes, *Size Matters (or Should) in Copyright Law*, 74 FORD. L. REV. 575 (2005). Some software would be included in "low-creativity" works, but other software is highly creative.

11. *See, e.g.*, Kal Raustiala & Christopher Sprigman, *The Piracy Paradox: Innovation and Intellectual Property in Fashion Design*, 92 VA. L. REV. 1687 (2006). The Author reserves a full exploration into this theme for other work. *See* Lucas S. Osborn, *Intellectual Property Channeling for Digital Works*, 39 CARDOZO L. REV. (forthcoming 2017) [hereinafter *Intellectual Property Channeling*].

12. In this Article, the Author does not normatively attack the current doctrine of originality, though one could. *See generally*, Joseph Scott Miller, *Hoisting Originality*,

and analyzing open-source hardware licenses[13] are called into question, because, without intellectual property protection, an open-source license generally will not bind those who lack privity with the original creator.

Finally, Section V introduces some potential caveats to the uncopyrightability of digital manufacturing files for useful objects. Specifically, it anticipates attempts by file creators to append non-essential copyrightable expression to the files. Creators can accomplish this by adding non-executable, creative comments to the file code (e.g., an original poem) or by adding a creative image in the file. The Article draws parallels between these appendages and other "lock-out codes," which users have employed to try to prevent otherwise lawful copying. The Article reserves normative judgment on these lock-out codes, but briefly analyzes potential doctrinal responses to the phenomenon.[14]

II. DIGITAL MANUFACTURING TECHNOLOGY AND DIGITAL FILES

At a minimum, digital manufacturing includes 3D printing, laser cutting, and computer numerically controlled ("CNC") manufacturing.[15] 3D printers build objects layer by layer, whereas CNC machines subtract material from an object, such as by milling or cutting.[16] 3D printing garners the current media spotlight,[17] but CNC manufacturing predates it by decades. Indeed, CNC manufacturing, broadly construed, enjoys a lengthy history almost as old as the computer era.

A. *CNC and 3D Printing*

One example of an early CNC manufacturing adopter is the aircraft manufacturer, Boeing. In 1953, Boeing ordered various numerically-controlled machine tools, in what was among the first integrations of computers with industry.[18] In the 1950s, Boeing engineers would con-

31 CARDOZO L. REV. 451 (2009); Gideon Parchomovsky & Alex Stein, *Originality*, 95 VA. L. REV. 1505 (2009).

13. *See* Eli Greenbaum, *Three-Dimensional Printing and Open Source Hardware*, 2 N.Y.U. J. INTELL. PROP. & ENT. L. 257 (2013).

14. For a normative analysis, see *Intellectual Property Channeling*, *supra* note 11.

15. *See* ADRIAN MCEWEN & HAKIM CASSIMALLY, DESIGNING THE INTERNET OF THINGS, 154–68 (Wiley 2014), http://www.shahrvan.org/wp-content/uploads/2016/06/Designing-The-Internet-Of-Things.pdf [https://perma.cc/7FMY-AB65].

16. *See* ANDERSON, *supra* note 1, at 81–83.

17. *See, e.g.*, Peter Basiliere, *Hype Cycle for 3D Printing, 2016: From the Trigger to the Mainstream (almost)*, GARTNER BLOG NETWORK (July 27, 2016), http://blogs.gartner.com/pete-basiliere/2016/07/27/hype-cycle-for-3d-printing-2016-from-the-trigger-to-the-mainstream-almost/ [https://perma.cc/F925-8YY6].

18. Norman Sanders, *A Possible First Use of CAM/CAD*, 387 IFIP ADVANCES IN INFORMATION AND COMMUNICATION TECHNOLOGY 43, http://dl.ifip.org/db/series/ifip/ifip387/Sanders12.pdf [https://perma.cc/KW52-ZW2V] ("In 1960, Ivan Sutherland at MIT's Lincoln Laboratory created Sketchpad, which demonstrated the basic principles and feasibility of computer-aided technical drawing.").

vert hand-made engineering drawings into a direct machine language or rough program language, which would direct the numerically-controlled machines to drill holes and make cuts in metal parts.[19] The "files" used by the machines consisted first of punched cards, and later of magnetic tape.[20] Since there were no computer screens during this time period, the punch cards had to be run on a CNC machine to determine what they would create.[21] By the early 1960s, Boeing engineers could calculate the shape of parts needed and produce computer outputs of those parts. The first computer outputs consisted of mere data that had to be hand-drawn with pain-staking accuracy.[22] Later, engineers figured out how to take the output and have a computer draw highly accurate drawings; however, because no accurate printers existed, they had to use a modified numerical control machine to etch the drawings onto aluminum sheets![23]

CNC manufacturing has matured into a well-established field that utilizes computer assisted drawings as inputs to machines for relatively seamless manufacturing.[24] Tools used in CNC include lathes, mills, routers, grinders, and lasers.[25] Although industry has used CNC for decades, individuals have begun to use the technology in increased numbers.[26]

As impressive as CNC manufacturing is, 3D printing overshadows it in the news.[27] 3D printing builds objects layer by layer, either extruding material from a nozzle or by using heat or light to manipulate a material in a layered process.[28] 3D printers can utilize diverse "printing" materials, including extruded or powdered plastic, metal, ceramic, food, cement, wood, and human cells.[29] 3D printers capture the

19. *Id.* at 44–45.

20. *Id.* at 45.

21. *See id.* at 46.

22. *Id.* at 47 ("There were cases of engineers spending three months drawing curves resulting from a single night's computer run.").

23. *Id.* at 51.

24. *See, e.g.*, William R. Thornewell II, *Patent Infringement Prevention and the Advancement of Technology: Applications of 35 U.S.C. § 271(f) to Software and "Virtual Components,"* 73 FORDHAM L. REV. 2815, 2823–26 (2005).

25. *See* MCEWEN & CASSIMALLY, *supra* note 15, at 149; *More About CNC Machining*, THOMASNET.COM, http://www.thomasnet.com/about/cnc-machining-45330503.html [https://perma.cc/QM8X-JSWB].

26. *See The Future*, *supra* note 3. Despite the fact that a laser is a tool controlled by a computer, it is common to consider laser cutters as separate from CNC machines. *See e.g.,* ANDERSON, *supra* note 1, at 83–84 (listing CNC machines and laser cutters separately).

27. *See, e.g.*, *A Third Industrial Revolution*, *supra* note 1.

28. *See, e.g.*, Lucas S. Osborn et al., *A Case for Weakening Patent Rights*, 89 ST. JOHN'S L. REV. 1185, 1192–94 (2015) [hereinafter *A Case for Weakening Patent Rights*].

29. *See* LIPSON & KURMAN, *supra* note 1, at 68–75; *Biofabrication—Fit to Print*, THE ECONOMIST (Apr. 6, 2013), http://www.economist.com/news/science-and-technology/21575745-new-ways-make-living-tissue-artificially-fit-print [https://perma.cc/V9K7-AB8T].

public imagination in part because they can print complex objects, including with moving parts, in a single print pass.[30]

B. *Files Used in Digital Manufacturing*

Before a user can digitally manufacture an object, the user must first create a computer model of it using any one of the various Computer-Aided Design ("CAD") programs such as Google Sketchup, AutoCAD, and the like. CAD programs as simple two-dimensional drawing programs existed at least by the 1960s.[31] Today there are a prodigious number of CAD programs, some available for free, that allow users to draw in two and three dimensions. While users can draw shapes from scratch in the programs, they typically select from a large menu of adjustable, predesigned shapes and objects (e.g., screws, cylinders, etc.).

The files that the law literature often refers to generically as CAD files can actually be grouped into three main categories. The first group consists of files that assist in drawing or manipulating the object, including files such as DWG files. These files often cannot be used directly for digital manufacturing; they must generally be converted into a separate format.

The second group consists of files that have been converted into a format that is unique to digital manufacturing, such as STL,[32] 3MF, and AMF for 3D printing,[33] and STEP files for CNC manufacturing.[34]

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30. For a detailed explanation of the technology, *see* LIPSON & KURMAN, *supra* note 1, at 68–84; *A Case for Weakening Patent Rights*, *supra* note 28, at 1192–97.

31. Interestingly, although Sketchpad may have been the world's first true CAD software, "the first commercial [computer aided manufacturing] CAM software system, a numerical control programming tool named PRONTO, had already been developed in 1957 by Dr. Patrick J. Hanratty." Cadazz, *CAD Software History, 1960s*, CADAZZ, http://www.cadazz.com/cad-software-history.htm [https://perma.cc/7RKZ-RH6K]; Sanders, *supra* note 18.

32. STL files are common in 3D printing. The letters "STL" are short for STereoLithography. *See 30 Years of Innovation*, 3D Systems, http://www.3dsystems.com/30-years-innovation [https://perma.cc/F3HW-SNVG]. Industry participants also refer to .stl as "Standard Tessellation Language." LIPSON & KURMAN, *supra* note 1, at 101. More advanced 3D printing files, including 3MF and AMF files that allow printing in colors, are gaining popularity.

33. *See What is 3mf*, 3MF CONSORTIUM (Mar. 21, 2017, 11:42 AM), http://3mf.io/what-is-3mf/ [https://perma.cc/FYL2-8BQK]; TJ McCue, *AMF Format for 3D Printing: A Possible STL File Format Replacement, the AMF has Some Benefits*, 3DPrinting.com (May 29, 2015), http://3dprinting.about.com/od/3D-Models/fl/AMF-Format-for-3D-Printing.htm [https://perma.cc/R7WW-VFG3].

34. *See Converting CAD to STL*, STRATASYS: THE 3D PRINTING SOLUTIONS COMPANY, http://www.stratasys.com/~/media/Main/Files/Best-Practices_BP/BP_DU_CADtoSTL_EN_1115.ashx [https://perma.cc/MRD5-2E5S] (describing file conversion); *see also* Doug Dingus, *What is the most popular file format used for sharing CAD files?*, QUORA (Dec. 22, 2014), https://www.quora.com/What-is-the-most-popular-file-format-used-for-sharing-CAD-files [https://perma.cc/R7QT-WKXB] (describing file types); *see also The STEP Standard*, STEP TOOLS, INC., http://www.steptools.com/library/standard/step_4.html [https://perma.cc/NBB3-GAHR].

Conversion from DWG format to STL format, for example, will change the shape of the object as depicted by the file. Specifically, the software approximates the surfaces of a solid model with triangles[35] (see image that follows the next four paragraphs).

Finally, the third group of files consists of any of the foregoing files that have been translated by software (slicer for 3D printing and CAM for CNC) into files that can speak almost directly to the manufacturing device (e.g., a 3D printer).[36] These files typically include one of the GCODE file types, but there are other types. GCODE files provide instructions to the machine about where to move, what to do, how fast, and when.[37] The software that generates GCODE files must know the particular details of the machine (e.g., 3D printer) that will manufacture the device.[38] GCODE files are translated into machine language (essentially ones and zeros or hexadecimal representations of ones and zeros) for use directly by the computer.

This Article refers to the first group of files as design files, the second group of files as manufacturing-ready files, and the third group as machine-instruction[39] files.[40] As should be clear, users can easily share design and manufacturing-ready files via the internet. Machine-instruction files, however, are shared less often because they may only work for other people who have the same machine (e.g., a specific 3D printer model), print material, etc. as the person who generated the machine-instruction file. In contrast, the manufacturing-ready file formats, such as STL, can be analogized to PDF documents in that they can be utilized across many different computer and 3D printer types.

To reemphasize, the design file is typically created by a user by drawing an object on a computer screen in a CAD program. Once the

35. *What is an STL File*, 3D SYSTEMS, INC., http://www.3dsystems.com/quickparts/learning-center/what-is-stl-file [https://perma.cc/8KMR-SMVN].

36. MCEWEN & CASSIMALLY, *supra* note 15, at 156; Bob Warfield, *Secrets of Going from CAD, Image, DXF, or STL to GCode for CNC and 3D Printing*, CNC COOKBOOK (Nov. 10, 2014), http://blog.cnccookbook.com/2014/11/10/secrets-going-cad-image-dxf-stl-gcode-cnc-3d-printing/ [https://perma.cc/8P6A-2SAU].

37. Warfield, *supra* note 36.

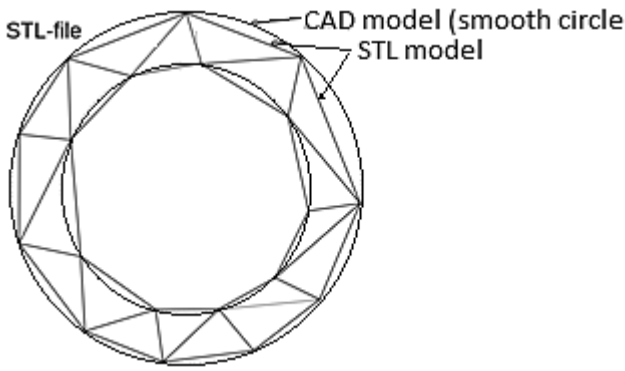
38. *Id.*

39. *See What file formats are used in 3D Printing?*, NATIONAL INSTITUTE OF HEALTH 3D PRINT EXCHANGE, https://3dprint.nih.gov/faqs/1781 [https://perma.cc/CRM5-N37K]. Machine-instruction files should not be confused with machine language, which is what results when machine-instruction files are converted into binary or hexadecimal language that is directly executable by a computer. *Machine language*, MERRIAM-WEBSTER, https://www.merriam-webster.com/dictionary/machine%20language [https://perma.cc/ZZ5H-8PFP].

40. Note that this usage is that of the Author and is not universal. Additional caveats are in order. Digital manufacturing tools continue to evolve at a rapid rate. The drawing file, manufacturing-ready file, and machine-instruction file paradigm described above represents the current "normal" way of digital manufacturing, but other ways exist already. For example, users can code shapes directly using text rather than drawing them. OpenSCAD represents one method, and it is possible to write GCODE directly. Nevertheless, the analysis provided in this Article can be readily extended to other digital manufacturing paradigms.

design file is complete, a user will utilize software to translate it into a manufacturing-ready file. Typically, the user will initiate a "print" command through the user's software to "print" the manufacturing-ready file. Initiating the print command typically causes software automatically to translate the manufacturing-ready file into a machine-instruction file (e.g., GCODE) based on the user's attached digital manufacturing device.[41] The machine-instruction file is, in turn, automatically translated into machine language and the digital manufacturing takes place. The user often sees nothing after instructing the computer to print the manufacturing-ready file; the next thing the user sees is the digital manufacturing device operating.

To use a 3D printing example, the design file is translated into an STL file, which is a triangulated depiction of the solid object. The following image shows how a design file's smooth curve is translated into an STL file.[42]



As shown in the figure, the shape of the object changes when the file is converted from a design file to a manufacturing-ready file in the 3D printing context. However, when the manufacturing-ready file is converted to a machine-instruction file, the overall object shape is unchanged; rather, the shape as depicted in the manufacturing-ready file is utilized exactly to provide precise instructions to the manufacturing device.

Though each file type is almost always created using software, a user can directly code (i.e., type directly in textual code format) all three file types. Regardless of how it is created, each file type can be

41. In some cases, users can manually specify options "like the temperature to which the plastic should be heated, how densely to fill the solid objects, [and] the speed at which the extruder head should move." MCEWEN & CASSIMALLY, *supra* note 15, at 165.

42. Lauren Van Lieshout, *File: The differences between CAD and STL Models.svg*, WIKIMEDIA COMMONS (Nov. 8, 2016, 22:18), https://commons.wikimedia.org/w/index.php?curid=34722631 [https://perma.cc/J7BX-JYHP] (this citation is to the original image, the image shown has been modified by the author from its original version).

displayed as lines of computer code and as an image on a computer screen. Below is a textual excerpt of a GCODE file for a simple washer.[43]

```
G1 Z15.0 F9000 ;move the platform down 15mm

G92 E0                  ;zero the extruded length
G1 F200 E3              ;extrude 3mm of feed stock
G92 E0                  ;zero the extruded length again
G1 F9000
;Put printing message on LCD screen
M117 Printing...

;Layer count: 12
;LAYER:0
M107
G0 F9000 X58.549 Y59.387 Z0.300
;TYPE:SKIRT
G1 F1800 X59.715 Y58.239 E0.03847
G1 X60.945 Y57.153 E0.07706
G1 X62.234 Y56.138 E0.11563
G1 X63.575 Y55.196 E0.15417
G1 X65.099 Y54.246 E0.19639
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In the past, the Author and other legal commentators have referred to 3D printing files generically as CAD files. Generalizing was, and is, fine for many analyses. But copyright is a technical subject, and technical differences in file types may result in different treatment by copyright law. The following Sections explore these technical differences and their effects.

III. DIGITAL FILES FOR CREATIVE WORKS

This Section will focus on copyright law's treatment of digital design, manufacturing, and machine-instruction files of creative objects, such as an artistic sculpture. Such files have utilitarian aspects—they contain data depicting the sculpture's dimensions and act as instructions for a machine. In this sense, design, manufacturing, and machine instruction files could be analogized to methods of construction, an undeniably utilitarian role.

The law is generally careful not to allow copyright law to protect things that, at their core, are utilitarian. Utilitarian creations are the province of patent law, not copyright law.[44] In fact, copyright law contains several doctrines to preclude copyright protection for useful creations, or, more precisely, to preclude protection for utilitarian aspects

43. The reader should note that text following each semi-colon constitutes a comment that has no effect on the file's functionality. The comments can be hand typed by a user and can contain anything, including fanciful or creative text.

44. *See* 35 U.S.C. § 101 (1952) (directing that patents are for useful articles); *see e.g.*, Viva R. Moffat, *The Copyright/Patent Boundary*, 48 U. RICH. L. REV. 611, 612 (2014) ("Patent law protects new, useful, and nonobvious inventions.").

of creations. Take for example computer software,[45] which is often primarily utilitarian in nature. Congress allowed copyright protection for software as a literary work, but only to the extent it incorporates a programmer's creativity in drafting the code; any strictly utilitarian feature or output is not protected.[46]

More pertinently to design files, the Copyright Act also includes within its non-exhaustive list of protectable works the category of "pictorial, graphic, and sculptural works" ("PGS works").[47] The statute defines PGS works in part as "two-dimensional and three-dimensional works of fine, graphic, and applied art, photographs, prints and art reproductions, maps, globes, charts, diagrams, models, and technical drawings, including architectural plans."[48] Aware that many three-dimensional objects, like gears and mousetraps, are utilitarian and not creative, the copyright statute limits the copyrightability of a PGS work by stating:

> Such works shall include works of artistic craftsmanship insofar as their form but not their mechanical or utilitarian aspects are concerned; the design of a *useful article*, as defined in this section, shall be considered a pictorial, graphic, or sculptural work only if, and only to the extent that, such design incorporates pictorial, graphic, or sculptural features that can be identified separately from, and are capable of existing independently of, the utilitarian aspects of the article.[49]

Hence, purely useful articles are not copyrightable, and useful articles that contain a mixture of utility and creativity are only copyrightable if the creative aspects are separable from the utilitarian aspects.[50]

And what is a useful article? Congress defined it as "an article having an intrinsic utilitarian function that is not merely to portray the appearance of the article or to convey information."[51] A mousetrap is a useful article because it has a utilitarian function of catching mice. A painting is not a useful article because its function is merely to portray its appearance.[52]

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45. Broadly defined, digital manufacturing files are software. But to this point, copyright law has primarily analyzed application programs and operating systems.

46. 17 U.S.C. § 117; H.R. Rep. No. 1476, 94th Cong., 2d Sess. 54 (1976) (stating that "literary works . . . includes computer programs to the extent that they incorporate authorship . . . . "); *see also* Apple Comput., Inc. v. Franklin Comput. Corp., 714 F.2d 1240, 1247–48 (3d Cir. 1983) (discussing statute and legislative history with respect to protection for programs). *See infra* Section IV.C for more on computer programs, including their protectable output.

47. 17 U.S.C. § 102(a) (2012).

48. 17 U.S.C. § 101.

49. *Id.* (emphasis added).

50. *See, e.g.*, Star Athletica, L.L.C. v. Varsity Brands, Inc., 137 S. Ct. 1002 (2017).

51. *Id.* at 1008.

52. One could quibble that a painting is a useful article that can be used to hide holes in a wall. But even if so, the pictorial features are easily separable from the utilitarian feature (the opaque canvas).

A. *Confusion #1: CAD Files are Not Copyrighted "Works"*

Having laid the statutory foundation, we can now analyze the copyright implications of digital design, manufacturing, and machine-instruction files that will manufacture a purely creative (i.e., copyrightable) work, such as an original sculpture. First, consider machine-instruction files. Although the files themselves have utilitarian aspects, including to depict the object on a computer screen and to provide instructions to a 3D printer or other digital manufacturing device, this is irrelevant under the copyright statute. Copyright law does not protect files *per se*. It instead protects works.[53] In the current example, the work is a sculpture.[54]

The file is a "copy" of the work, but the file *qua file* is not the work, just like a canvas is not the work with respect to a painting.[55] According to the statute, copies are "material objects, other than phonorecords, in which a work is fixed by any method now known or later developed, and from which the work can be perceived, reproduced, or otherwise communicated, either directly *or with the aid of a machine or device*."[56] In the machine-instruction file, the sculpture is "fixed" in computer memory[57] and can be "perceived" with the aid of a machine in that the sculpture is visible once it is printed.

Moreover, because a computer can portray an image of the sculpture on a computer screen, the file also constitutes a copy of a pictorial or graphic work. And, because the file is also represented in textual form (i.e., code), it constitutes a copy of literary work. If the

53. 17 U.S.C. § 102 ("Copyright protection subsists . . . in original works of authorship fixed in any tangible medium of expression . . . . "); *see also* Mark P. McKenna & Lucas S. Osborn, *Trademarks and Digital Goods*, 92 NOTRE DAME L. REV. 1425, 1459 (2017) ("[C]opyright attaches to the intangible work of authorship, *not* to the tangible copy in which it is fixed.").

54. And, as will be explained, the file also embodies a "pictorial/graphic" work and a "literary" work.

55. *See* 17 U.S.C. § 101. It is true, however, that "the term 'copies' includes the material object . . . in which the work is first fixed." But the work is a disembodied sculpture or picture. Although the list of works in § 102 is not exhaustive, H.R. Rep. No. 94-1476, at 53 (1976), the objects created or depicted (or the text depicted) by digital manufacturing files fit comfortably within the already listed works.

56. 17 U.S.C. § 101 (emphasis added).

57. Apple Comput., Inc. v. Franklin Comput. Corp., 714 F.2d 1240, 1249 (3rd Cir. 1992) (reaffirming that a computer program in object code embedded in a ROM chip is an appropriate subject of copyright); M. Kramer Mfg. Co. v. Andrews, 783 F.2d 421, 441 (4th Cir. 1986) (holding that audiovisuals are "fixed" in a "memory device"); Stern Elecs., Inc. v. Kaufman, 669 F.2d 852, 855–56 (2d Cir. 1982) (holding that a video game's audiovisual display is "fixed" in ROM); Midway Mfg. Co. v. Dirkschneider, 543 F. Supp. 466, 480 (D. Neb. 1981) (holding that audiovisual works are fixed in printed circuit boards (i.e., computer memory) because they are tangible objects from which the audiovisual works can be perceived for a time period that is more than transitory); James Grimmelmann, *There's No Such Thing as a Computer-Authored Work—And It's a Good Thing, Too*, 39 COLUM. J.L. & ARTS 403, 405 (2016) ("Bits may be abstract and intangible, but memory chips and hard drives are very much 'material objects.'").

file contained information to manufacture a building rather than a sculpture, the file would constitute a copy of an architectural work.

There seems to be some confusion about this in the literature. The Author believes the confusion starts with a correct but potentially misleading inquiry into whether "CAD files are copyrightable."[58] In many cases, this is a harmless portmanteau of the concept that copying someone else's CAD file (or, as used herein, digital manufacturing file) might infringe a copyright in a protected work, for which the file serves as a copy. In this sense, the usage is ubiquitous and correct.[59]

But some commentators erroneously suggest that CAD files constitute their own category of a work, as opposed to merely being copies of existing categories of works (such as literary works or PGS works).[60] While the list of works in § 101 is not exhaustive,[61] it is broad enough to include all the works that may be embodied in computer programs, which is why Congress did not add computer programs to the list of copyrightable works under § 101.[62] Digital

58. *See* Kyle Dolinsky, Note, *CAD's Cradle: Untangling Copyrightability, Derivative Works, and Fair Use in 3D Printing*, 71 WASH. & LEE. L. REV. 591, 627–57 (2014) (analyzing the "copyrightability" of CAD files); Lucas S. Osborn, *Of PhDs, Pirates, and the Public: Three-Dimensional Printing Technology and the Arts*, 1 TEX. A&M L. REV. 811, 824–34 (2014) [hereinafter *Of PhDs, Pirates, and the Public*] (at times referring to the copyrightability of CAD files); Nathan Reitinger, Comment, *CAD's Parallel to Technical Drawings: Copyright in the Fabricated World*, 97 J. PAT. & TRADEMARK OFF. SOC'Y 111, 133 (2015) (analyzing how to "assert a copyright on the CAD file itself.").

59. *See, e.g.*, Commission on New Technological Uses of Copyrighted Works, 18 (July 31, 1978) (The same phrase is used throughout earlier literature analyzing the copyrightability of computer software.) [hereinafter "CONTU"].

60. *See* Dolinsky, *supra* note 58, at 628–57 (performing a search for the appropriate analogy to CAD files among other works that copyright protects and concluding that CAD files are not perfectly analogous to architectural plans or technical drawings, inter alia); Reitinger, *supra* note 58, at 133–34 (analyzing how to "assert a copyright on the CAD file itself" and concluding that CAD files should be copyrightable by analogy to technical drawings); Brian Rideout, *Printing the Impossible Triangle: The Copyright Implications of Three-Dimensional Printing*, 5 J. BUS. ENTREPRENEURSHIP & L. 161, 168 (2011) (while otherwise analyzing the issue correctly, erroneously concluding that CAD files are not "copyrightable software" because they are "more of a blueprint"); Sarah Swanson, Note, *3D Printing: A Lesson in History: How to Mold the World of Copyright*, 43 SW. L. REV. 483, 489 (2014) ("Another option is to create a new category of protection or qualify the object and digital blueprint as a new medium."). If commentators merely meant that CAD files should be analogized to *paper* technical drawings, then there would be no error. But the commentators seem to suggest that CAD files are not copies of technical drawings, and instead are something different. *But see* Tesh W. Dagne & Chelsea Dubeau, *3D Printing and the Law: Are CAD Files Copyright-Protected?*, 28 INTELL. PROP. J. 101, 118–122 (2015) (correctly analyzing CAD files under Canadian law that is analogous to U.S. law); James Grimmelmann, *Indistinguishable from Magic: A Wizard's Guide to Copyright and 3D Printing*, 71 WASH. & LEE. L. REV. 683, 684-88 (2014) (correctly, and humorously, analyzing files under U.S. law); *Of PhDs, Pirates, and the Public*, *supra* note 58, at 825–26 (noting that CAD files may be protectable as literary works or PGS works).

61. *See, e.g.*, CONTU, *supra* note 59, at 15.

62. *Id.* at 16 (quoting H.R. Rep. No. 94-1476, at 51 (1976) and S. Rep. No. 94-473, at 50–51 (1976)).

manufacturing files are not a separate category of work.[63] Rather, they are copies of works. Thus, the question is not whether the files are copyrightable; the question is whether the work (or works) embodied in the files are copyrightable.

Currently, the literature is inexact and confused at times and often simply wrong regarding copyright law's application to digital manufacturing files.[64] This is not merely academic pedantry. The confusion unnecessarily complicates the analysis[65] and leads to multiple errors with downstream consequences.[66] For instance, as mentioned in the preceding paragraph, the error obscures the fact that one must analyze the files in terms of the work(s) they embody, which can include a sculptural work, a pictorial or graphic work, a literary work, and an architectural work. To determine whether copying a file constitutes infringement, one must separately analyze each category of work that the file might embody.

Understanding the proper framework makes the analysis of our hypothetical original and creative sculpture easy. Because the sculpture is copyrightable, copying its corresponding digital file (the copy) constitutes infringement under § 102(a).[67] To spell it out directly in the statute's vernacular, the machine-instruction file (e.g., GCODE) is a protected copy because it is fixed in computer memory and the sculpture (the work) can be perceived with the aid of a machine, such as a 3D printer.[68] Likewise, the manufacturing-ready file is similar, with

63. Though they do constitute "computer programs" within the meaning of the copyright statute. The statute defines a computer program as "a set of statements or instructions to be used directly or indirectly in a computer in order to bring about a certain result." 17 U.S.C. § 101. This includes not only application programs, but also what are commonly referred to simply as files. A digital manufacturing file contains all the information (i.e., "instructions") to be used by a digital manufacturing machine (i.e., a "computer") to print a three-dimensional object (i.e., "bring about a certain result"). *Of PhDs, Pirates, and the Public*, *supra* note 58, at 825. Likewise, a JPEG file constitutes a computer program in that it contains instructions for a computer to display an image.

64. Although the Author critiques several works, the Author wants to highlight the generally high quality of work and thought that went into many of the articles, especially considering some are student notes.

65. *C.f.* Dolinsky, *supra* note 58, at 642–51 (proposing a "composite test for copyrightability of CAD files.").

66. *See* Greenbaum, *supra* note 13, at 275 (erroneously concluding that digital manufacturing files depicting useful articles "easily qualify for copyright protection" because "[c]opyright law protects 'pictorial, graphic and sculptural works,'" including "technical drawings"). Unfortunately for Mr. Greenbaum, his premature conclusion that all digital manufacturing files are protected by copyright imperils his entire open source hardware license.

67. 17 U.S.C. § 102(a) ("Copyright protection subsists, in accordance with this title, in original works of authorship fixed in any tangible medium of expression, now known or later developed, from which they can be perceived, reproduced, or otherwise communicated, either directly or with the aid of a machine or device.").

68. In actuality, there is an intermediate transformation from GCODE into machine language, but a machine performs that transformation automatically.

the added step that a computer automatically translates the manufacturing-ready file into GCODE and then a 3D printer prints the file.[69]

The analysis of the design file invites deeper scrutiny. Some design files must be modified before they can be translated into manufacturing-ready files that will correctly print the object.[70] In cases where the modification requires extensive human intervention, the design file would no longer constitute a copy of the physical sculpture because a human cannot perceive the sculpture simply with the aid of a machine.[71] On the other hand, technology can sometimes automatically fix design-flawed files.[72] Such "repair" technologies will doubtless improve to the point where one can simply push a single button to "print" (manufacture) directly from the design file.[73]

In addition to sculptural works, digital files that will manufacture sculptures may simultaneously serve as copies of pictorial or graphic works. Because a design, manufacturing, and machine-instruction file can each, through the use of a machine, allow a user to perceive a two-dimensional picture of the sculpture on a computer screen, these files constitute copies as defined in the copyright statute.[74] Continuing the assumption that the depicted sculpture is original and creative, any unauthorized copy of the sculpture file constitutes prima facie infringement under § 102(a).[75]

B. *Confusion #2: CAD Files are Not "Useful Articles"*

The confusion about what constitutes copyright-eligible works, as opposed to copies of works, also leads to confusion and complication on the subject of useful articles. Because commentators erroneously

69. The Author is thankful to Michael Weinberg for the conversations that helped crystalize the analysis in this section.

70. *See, e.g.*, Jeff LaMarche, *Preparing Blender Files for 3D Printing*, SHAPEWAYS, http://www.shapeways.com/tutorials/prepping_blender_files_for_3d_printing [https://perma.cc/8F33-JSF7].

71. As discussed in the next paragraph, this does not necessarily mean the file is not a copy of another protected work, such as a pictorial work.

72. *See, e.g.*, *Automatically Repair STL Files in 2 Minutes with netfabb*, 3D ADDITIVE FABRICATION (Mar. 19, 2012), http://3daddfab.com/blog/index.php?/permalink/Automatically-Repair-STL-Files-in-2-Minutes-with-netfabb.html [https://perma.cc/HHD2-BFY4] ("In this post we're going to go through a simple example showing how to use a great free tool, netfabb Studio Basic ('netfabb') to automatically 'repair' STL files for 3D printing.").

73. Here the term "directly" means directly from the user's perspective. *See* 17 U.S.C. § 102(a) (2017). The file will undergo repair, then conversion to a manufacturing-ready file, followed by conversion to a machine-instruction file (and then to machine language), until it is finally printed or manufactured. But because all of this is through a machine that allows the user to perceive the physical sculpture, it is a protected copy under 17 U.S.C. § 102(a). *See id.*

74. *See* 17 U.S.C. § 101 (2017).

75. One can perform a similar analysis to demonstrate the file is protectable as a copy of a literary work, for which the creativity of the code is inherently based on the creativity of the underlying sculpture.

consider CAD files works, they in turn erroneously analyze whether the CAD file itself—as opposed to the object the CAD file would manufacture—constitutes a useful article under the statute.[76] This error multiplies as commentators then must analyze whether the CAD file has non-useful features that are physically or conceptually separable from the utilitarian aspects. This is most likely an unnecessary inquiry because the CAD file is not the useful article referred to in the statute.[77] The only useful article inquiry necessary is whether the object the digital file would manufacture is a useful article. The hypothetical sculpture is not a useful article.

Alternatively, one could consider files as useful articles, but not in any way that meaningfully affects the copyright analysis. This issue recalls a debate from the *Star Athletica* case, in which the copyright owner argued there was no need for a separability analysis regarding the patterns included on cheerleading outfits, because the protectable work (a pictorial work) was simply placed *on* a useful article (the blank outfit), rather than being a design *of* a useful article.[78] The *Star Athletica* Court rejected this contention as "inconsistent with the text of § 101."[79] The Court stated that the useful article was the (blank) outfit itself, but that the pictorial work was a separable feature of the outfit.[80] Because files *as data* are abstract, it is difficult to extend the Court's reasoning to digital manufacturing files. If one insisted on following the Court's reasoning, one could analogize blank memory media (e.g., a CD or portion of a disk drive) to the blank cheerleading outfit and data representing the sculpture to the colorful designs

76. *See* Dolinsky, *supra* note 58, at 633–34 (stating that it is unclear whether CAD files constitute useful articles); Darrell G. Mottley, *Intellectual Property Issues in the Network Cloud: Virtual Models and Digital Three-Dimensional Printers*, 9 J. BUS. & TECH. L. 151, 159–161 (2014) (analyzing CAD files as useful articles rather than analyzing the object depicted by the CAD file); Reitinger, *supra* note 58, at 136 (analyzing CAD files as useful articles rather than analyzing the object depicted by the CAD file); *Of PhDs, Pirates, and the Public*, *supra* note 58, at 832–34 (analyzing whether CAD files constitute useful articles instead of analyzing whether the object depicted by the file constitutes a useful object). As even the Supreme Court confused a similar issue, perhaps everyone gets a pass. *See* Star Athletica, L.L.C. v. Varsity Brands, Inc., 137 S. Ct. 1002, 1011 (2017) (stating that "The ultimate separability question, then, is whether the feature for which copyright protection is claimed would have been eligible for copyright protection as a pictorial, graphic, or sculptural work had it originally been fixed *in some tangible medium other than a useful article* before being applied to a useful article," but failing to realize that any tangible medium (paper, canvas, etc.) is a useful article in some sense) (emphasis added). Professor Grimmelmann correctly analyzes CAD files used in 3D printing. Grimmelmann, *supra* note 60, at 689 ("But the 'functionality' of scrolls and CAD files is a red herring when their function is to produce copyrightable objects.").

77. *See, e.g.*, 2 WILLIAM F. PATRY, PATRY ON COPYRIGHT § 3:145 (March 2017 update) (stating that one must ask "if the design for which protection is sought is a PGS work, is the three-dimensional article that it is the design of, according to the statutory definition, a 'useful article.'").

78. Star Athletica, L.L.C. v. Varsity Brands, Inc., 137 S. Ct. 1002, 1009 (2017).

79. *Id.*

80. *Id.* at 1012.

placed on the cheerleading outfit. But this exercise would lead to the same result as before: the creative sculpture is easily separable from the physical computer memory.[81]

IV. DIGITAL FILES OF USEFUL ARTICLES

This Section will analyze the copyrightability of design, manufacturing, and machine-instruction files used to create utilitarian physical objects that contain no copyrightable expression because they are useful articles. Examples include digital files for screws, shovels, or engine parts.[82]

A. *The File as a Sculptural Work*

The previous Section clarified that manufacturing-ready and machine-instruction files can constitute copies of a sculptural work. Given the assumption in this Section that the object manufactured by the files are purely utilitarian, the analysis of the files is straightforward: they are not protectable copies of sculptural works. When the underlying physical object is a useful article[83] with no separable artistic features, it contains no protectable creativity.[84] Thus, the physical object is not a "sculptural work," and for that reason neither the manufacturing-ready file nor the machine-instruction file is a copy of a sculptural work.

Looking to the design file, if the design file requires significant human intervention to translate it into a manufacturing-ready file, it would not constitute a copy of any sculptural work because it cannot be perceived as a sculpture directly or with the aid of a machine alone.[85] On the other hand, even if a user can rely on a computer or machine automatically to translate a design file and create an object, the file is still not a protectable copy for the same reason as the manufacturing-ready and machine-instruction files (i.e., that the underlying object is not a protectable work).

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81. For that matter, one could apply the Court's reasoning to an oil-on-canvas painting. The (blank) canvas is a useful article, but the painting applied thereto is easily separable.

82. *See, e.g.*, Star Athletica, L.L.C. v. Varsity Brands, Inc., 137 S. Ct. 1002, 1013 n.2 (2017) (stating that a shovel is not copyrightable).

83. 17 U.S.C. § 101 (2017) ("A 'useful article' is an article having an intrinsic utilitarian function that is not merely to portray the appearance of the article or to convey information.").

84. *See id.* (stating that "the design of a useful article, as defined in this section, shall be considered a pictorial, graphic, or sculptural work only if, and only to the extent that, such design incorporates pictorial, graphic, or sculptural features that can be identified separately from, and are capable of existing independently of, the utilitarian aspects of the article.").

85. *See id.* (stating that "[c]opies are material objects, other than phonorecords, in which a work is fixed by any method now known or later developed, and from which the work can be perceived, reproduced, or otherwise communicated, either directly or with the aid of a machine or device.").

Although digital manufacturing files of purely utilitarian objects are not protectable as sculptural works, the analysis does not end there. Recall that a single computer file or program can embody more than one copyrightable work, such as when a computer program for a video game constitutes both a literary work (in the written code) and an audiovisual work (the game's output on a screen).[86] Digital manufacturing files can embody at least three copyrightable works: a sculpture, a pictorial or graphic work, and a literary work.[87]

B. *The File as a Pictorial/Graphic Work*

A digital manufacturing file of a purely utilitarian object can display a two-dimensional picture of the object on a computer screen, and thus might constitute a pictorial/graphic work.[88] Although an exact-to-scale drawing of a purely utilitarian object might seem an odd subject for copyright protection, the statute specifically includes "technical drawings" in the list of PGS works.[89] Because a computer can use the digital manufacturing file to display the technical drawing, the file constitutes a copy of the technical drawing,[90] though some commentators misapprehend this fact.[91]

86. *See, e.g.*, Stern Elecs., Inc. v. Kaufman, 669 F.2d 852, 855–56 (2d Cir. 1982) (stating that a video game can constitute a copy of both a literary work and an audiovisual work).

87. If the digital manufacturing file will manufacture a building, it can also constitute an architectural work. *See* 17 U.S.C. § 101 (2017) (defining architectural work). Regarding 3D printing buildings, *see, e.g.*, David L. Chandler, *3-D Printing Offers New Approach to Making Buildings*, MIT NEWS (Apr. 26, 2017), http://news.mit.edu/2017/3-d-printing-buildings-0426.

88. *See* 17 U.S.C. § 101 (defining PGS work).

89. *See id.*

90. *See id.* (defining copy).

91. *See* Dolinsky, *supra* note 58, at 627–57 (performing a search for the appropriate analogy to CAD files among other works that copyright protects and concluding that CAD files are not perfectly analogous to architectural plans or technical drawings). It is possible to argue that files for purely utilitarian objects are non-protectable as useful articles. Most technical drawings are not useful articles because they merely "convey information" to humans, thus bringing them outside the definition. 17 U.S.C. § 101. But digital manufacturing files for purely utilitarian objects do not exist primarily to convey information to humans. Rather, they exist to provide manufacturing instructions to a digital manufacturing device. In that sense, they could be considered useful articles with no separable expression. Section 101 does not specify that the exception of items that merely convey information must be directed to humans. But the COMPENDIUM OF U.S. COPYRIGHT OFFICE PRACTICES, a highly influential administrative publication, states, "[a]n item or object is considered a useful article if it performs any inherent or intrinsic utilitarian function other than to inform, entertain, or portray its appearance *to human beings*." U.S. COPYRIGHT OFFICE, COMPENDIUM OF U.S. COPYRIGHT OFFICE PRACTICES § 924.1 (3d ed. 2014). Much like courts refuse to consider a shovel as a protectable sculpture even though it could be used as such, they might refuse to consider a utilitarian digital manufacturing file as being used to convey information to humans even though it could be used as such. This analysis is less sound than one focusing on creativity. It might, for example, incorrectly suggest that a digital file for a creative sculpture or song is also a useful article, though they may be distinguished based on their creative output.

Other commentators understand that a digital manufacturing file can qualify as a copy of a technical drawing, but then erroneously assume that the file is thereby automatically protected by copyright.[92] Before a technical drawing can be protected against copying, however, it must constitute an original work of authorship that includes some modicum of creativity.[93] Not all technical drawings are copyrightable, however, because some lack any meaningful creativity.

1. Technical Drawings as . . . well . . . Purely Technical

Traditional technical drawings (i.e., those made exclusively for human viewing to aid in manual construction) contain modest creativity in the manner in which the object is depicted and the way it is labeled.[94] For example, a draftsperson can decide to include various views of the object, such as a top view, side view, perspective view, various "zoomed in" views, and exploded views. These decisions, while made in part for utilitarian reasons, may often contain the minimal creativity required under *Feist*.[95] Further, a draftsperson can decide which parts to label and how to label them, typically with lines

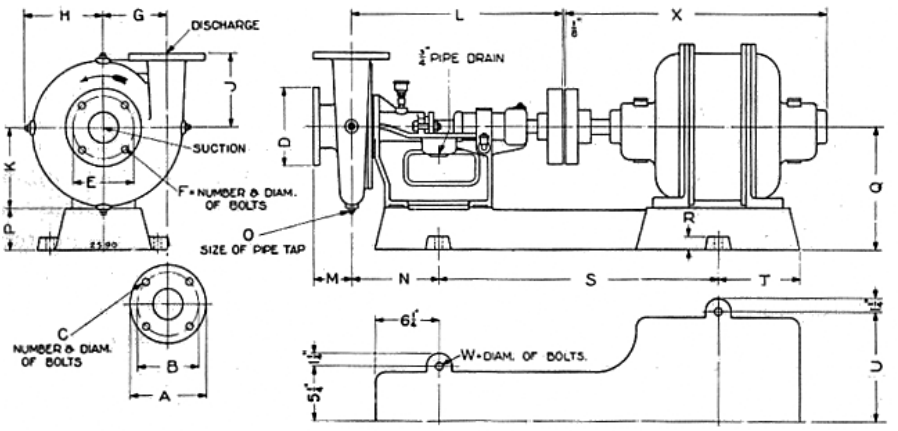
92. *See* Dolinsky, *supra* note 58, at 644–45 (stating that "[b]ecause the creativity threshold is low, the drawing component of any CAD file depicting a wholly novel—and therefore necessarily independently created—design would be copyrightable," where the author appears to be using the term "wholly novel" to include purely utilitarian objects that did not exist previously in physical form); Greenbaum, *supra* note 13, at 275 (stating that CAD and STL files of useful articles "easily qualify for copyright protection" because "[c]opyright law protects 'pictorial, graphic and sculptural works,'" including "technical drawings"); Reitinger, *supra* note 58, at 135–36 (stating that CAD files that are independently created automatically contain artistic expression); Frank Ward, *Patents & 3D Printing: Protecting the Democratization of Manufacturing by Combining Existing Intellectual Property Protections*, 25 DEPAUL J. ART, TECH. & I.P. L. 91, 110, 131–36 (2014) (arguing that most CAD files of a useful article are copyrightable as technical drawings in part because they are "certain to meet the 'minimal degree' of creativity.").

93. *See, e.g.*, Feist Publ'ns, Inc. v. Rural Tel. Serv. Co., 499 U.S. 340, 346 (1991) (explaining that originality requires independent creation plus a modicum of creativity); Haritha Dasari, Note, *Copyright Issues Involved With 3D Printing and Scanning*, 41 AIPLA Q.J. 279, 293 (2013) (noting that a CAD drawing must include a modicum of creativity); *Of PhDs, Pirates, and the Public*, *supra* note 58, at 829 ("Of course, technical drawings can be copyrighted only to the extent that they contain some minimal creativity.").

94. *Of PhDs, Pirates, and the Public*, *supra* note 58, at 829–30.

95. *See* Axxiom Mfg., Inc. v. McCoy Invs., Inc., 846 F. Supp. 2d 732, 748 (S.D. Tex. 2012) ("Because more than one way exists in which to create an exploded-parts drawing of the Schmidt valves (or an aftermarket version of the valves), the merger doctrine does not apply."); Goss Int'l Ams. Inc. v. A-American Mach. & Assembly Co., No. 07 C 3248, 2007 WL 4294744, at *2 (N.D. Ill. Nov. 30, 2007) (holding that exploded-parts drawing of printing-press parts was copyrightable).

leading from a specific part to a balloon that specifies the part name.[96] An example of a relatively simple technical drawing is shown below:[97]



CODE WORD	PIPE SIZES DISCH.	SUCT'N.	DIMENSIONS IN INCHES A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T	U	W	X
JAY	1½"	2"	TAPPED OPENINGS						5¼	6¼	6¼	7¾	20¼	3¼	8¼	¾								
JABBER	2"	2½"	6	4¼	4-⅜	7	5½	4-¾	5⅝	7¼	6½	7¾	20¾	3	8½	¾								
JACKET	3"	3"	7½	6	4-⅜	7½	6	4-¾	6¼	7⅝	7	7¾	20¾	3¼	8½	¾	ABOVE DIMENSIONS DETERMINED BY SIZE OF MOTOR AND BASE USED							
JACK	4"	4"	9	7½	8-¾	9	7½	8-¾	7⅝	8¼	7½	8⅝	22⅝	4¼	10	1								
JACOBUS	5"	5"	10	8½	8-¾	10	8½	8-¾	8¼	9¼	8¼	8⅝	22⅝	5	10¼	1								

But not all technical drawings include creative choices. Some may include only the minimum information necessary to meet the utilitarian purposes of the drawing, or the slight creativity they embody may "merge" with the utilitarian function or idea of the drawing.[98] In either case, the drawing would not receive copyright protection.

The view that pure technical drawings lack copyrightable creativity is unlikely to be universally held. The extended debates about protection for software menu hierarchies and APIs involve some of the same

96. Alternatively, the balloon can simply list a number that corresponds to a numbered part list. Simply choosing the numbers to assign to each part involves some creativity. *Cf. Assembly Drawings*, MIDDLE E. TECH. U., http://www.me.metu.edu.tr/courses/me114/Lectures/assembly.htm [https://perma.cc/6Q65-989K] (providing an example of a unit assembly drawing labeling parts with numbered balloons).

97. *Id.*

98. Regarding merger, *see generally* Apple Computer, Inc. v. Franklin Computer Corp., 714 F.2d 1240, 1253 (3d Cir. 1983) (stating the merger test as "whether the expression and idea have merged" and that merger occurs "where there are no or few other ways of expressing a particular idea"); Herbert Rosenthal Jewelry Corp. v. Kalpakian, 446 F.2d 738, 742 (9th Cir. 1971) (analyzing the line between idea and expression and stating that the "guiding consideration in drawing the line is the preservation of the balance between competition and protection reflected in the patent and copyright laws."). Courts faced with a merger analysis can decide a case one of at least three ways. First, they may decide the simple choices merge with the function and give no copyright protection. Alternatively, courts may find some protectable expression and grant a "thin" copyright that essentially protects only against verbatim copying. Finally, a court can reserve a merger analysis for the issue of infringement. *See* Oracle Am., Inc. v. Google Inc., 750 F.3d 1339, 1354–58 (Fed. Cir. 2014).

theoretical sticking points.[99] Much of the debate focuses on whether the programmer exercises enough choice to engender protectable creativity. Of course, choices constrained by utilitarian concerns or representing scenes a faire are not protectable under copyright law.[100] More perplexing are choices that appear creative ex ante but, when viewed ex post, represent non-protectable subject matter. APIs and menu hierarchies fall under this category, and courts do not agree on their copyrightability.[101] When a spreadsheet program designer chooses to label the function to store a file in computer memory as "save" instead of "store" or "preserve," there is ex ante choice. But as implemented (ex post), the spreadsheet hierarchy is a method of operation and thus unprotectable. Similarly, when designing even a utilitarian shovel there are ex ante choices as to lengths and angles. Many choices of course will be made based on utilitarian constraints. But at some level some choices will be arbitrary at best. Nevertheless, ex post, the choices result in a purely utilitarian shovel, and the drawing exactly depicting that shovel lacks protectable creativity. One cannot view the "pictorial/graphic" aspect of the drawing (especially a 3D printable digital depiction) in isolation from its purpose and function any more than one can view an accounting form[102] or API in isolation from its function.

Another way of viewing the same issue is to use the familiar idea/expression dichotomy: ideas are not protected but expression is. At a high level of abstraction, shovels can come in many shapes and sizes just like menu hierarchies and accounting forms can come in many varieties. But at a lower level of abstraction, there is only one way to draw a shovel with a three-foot handle, a spade that is one foot across and one foot long with rounded corners, etc. Unlike software, which as a literary work can achieve a particular functional result using multiple different coding approaches, there is only one way to depict a technically accurate shovel of certain dimensions. If the shovel's han-

99. *See, e.g.*, Peter S. Menell, *Analysis of the Scope of Copyright Protection for Application Programs*, 41 STAN. L. REV. 1045 (1989). APIs and menu hierarchies involve network effects and interoperability concerns that do not have direct parallels in 3D printing. *See id.* Yet in some engineering applications, tolerances (dimensions) are so tight that attempting to independently create the same object from scratch in CAD may be extremely difficult. *See* Rockwell Graphic Sys., Inc. v. DEV Indus. Inc., 925 F.2d 174, 175 (7th Cir. 1991) (noting the importance of tolerances in manufacturing machine parts).

100. Comput. Assocs. Int'l. v. Altai Inc., 982 F.2d 693, 708 (2d Cir. 1992).

101. For almost two decades the courts seemed largely settled on refusing protection for hierarchies and the like. Lotus Dev. Corp. v. Borland Int'l, Inc., 49 F.3d 807 (1st Cir. 1995) (refusing protection for spreadsheet menu hierarchy), *aff'd by an equally divided court*, 516 U.S. 233 (1996). But a recent appellate decision has revived the debate. *See* Oracle America, Inc. v. Google Inc., 750 F.3d 1339, 1349 (Fed. Cir. 2014) (holding that the declarations and organization of certain Java APIs copied by Google enjoyed copyright protection).

102. Baker v. Selden, 101 U.S. 99, 104 (1879) (refusing protection for an accounting form needed to perform a particular accounting method).

dle is three feet long, the line drawn must correspond (at scale) to a three-foot long handle. And so on with each part of the shovel.

A recent decision demonstrates the possibility of non-protected technical drawings. The court in *Enterprises Int'l., Inc. v. International Knife & Saw, Inc.*[103] refused copyright protection for the plaintiffs' technical drawings because the "designs *admittedly* contain only functional and utilitarian information, the sole purpose of which is to manufacture specific types of knives or blades to precisely fit certain machines."[104] The court's analysis was sparse and did not discuss the possibility that creativity in the selection and arrangement of the functional and utilitarian information might elevate the drawing to copyrightable status. Nevertheless, in principle, the court was correct: if everything in the drawing was present and arranged for purely functional and utilitarian reasons, it lacks any protectable creativity.

A related case involving digital technology likewise supports the idea that many digital drawings lack creativity. The Tenth Circuit in *Meshwerks, Inc. v. Toyota Motor Sales U.S.A., Inc.*,[105] held that Meshwerks' digital model of a Toyota car could not enjoy copyright protection.[106] Meshwerks created the digital models from measurements taken from actual cars that were fed into digital modeling software.[107] Meshwerks "personnel fine-tuned or, as the company prefers it, 'sculpted,' the lines on screen to resemble each vehicle as closely as possible."[108] Although the court's analysis focused on the fact that Meshwerks *copied* the car—and thus, the court believed, did not independently create the model[109]—implicit in the court's reasoning was that the model lacked any creativity.[110] For example, the court highlighted that "Meshwerks did not make any decisions regarding lighting, shading, the background in front of which a vehicle would be posed, the angle at which to pose it, or the like."[111] The case thus stands for the proposition that representing an object exactly true-to-

103. No. C12–5638 BHS, 2014 WL 1365398 (W.D. Wash. Apr. 7, 2014).

104. *Id.* at *6 (emphasis in original). Apparently relying on the plaintiff's own admission, the court did not provide a detailed analysis, nor did it provide a copy of the drawing at issue. *Id.* at *5–7.

105. 528 F.3d 1258 (10th Cir. 2008).

106. *Id.* at 1269–70.

107. *Id.* at 1260.

108. *Id.* According to *Meshwerks*, about 90% of the data points contained in each final model resulted from manual editing by employees, and the total process took almost 100 hours per vehicle. *Id.* at 1260–61.

109. *Id.* at 1263–69. Professor Ed Lee criticizes the court's failure to recognize the difference between copying a copyrighted "work" versus an uncopyrighted object from the world. Edward Lee, *Digital Originality*, 14 VAND. J. ENT. & TECH. L. 919, 928–30 (2012).

110. *See Meshwerks*, 528 F.3d at 1265–67.

111. *Id.* at 1265. The court continued, stating, "in short, its models reflect none of the decisions that can make depictions of things or facts in the world, whether Oscar Wilde or a Toyota Camry, new expressions subject to copyright protection." *Id.*

form will not involve a modicum of creativity, even if it requires extensive effort.[112]

Many digital manufacturing files of purely utilitarian objects contain no protectable creativity in the drawing.[113] The clearest cases are the manufacturing-ready (e.g., STL) and machine-instruction (e.g., GCODE) files. The depictions contain only one "view" and no part labels, as opposed to the many views and various labels depicted in many traditional technical drawings.[114] Every aspect of the drawing, every line and curve, exists entirely to depict the exact utilitarian object. There is only one way to depict the shovel—if ten other people independently created an STL file of the same shovel, each drawing would be identical. Moreover, the drawing cannot be viewed in isolation from the file's function, which is to manufacture a utilitarian object.

Design drawings (i.e., those created by a user in a CAD program) require a case-by-case copyright analysis, primarily because some design drawings may contain information that is not strictly required for manufacturing.[115] For example, design drawings may include labels, views, parts lists, and legends that may involve modest creative

112. Extensive effort does not give rise to copyright rights in the United States. Feist Publ'ns, Inc., v. Rural Tel. Serv. Co., 499 U.S. 343 (1991). The "sweat of the brow" doctrine has more viability abroad. *See* Databases Directive 96/9/EC (protecting databases). United Kingdom law traditionally endorsed a version of the sweat of the brow doctrine, *see, e.g.*, Independent Television Publications Ltd. v. Time Out Ltd. [1984] FSR 64, but recent EU decisions called the view into question. *See, e.g.*, Infopaq International v. Danske Dagblades Forening [2009] ECDR 16 (Case C-5/08); Football Dataco Ltd. v. Yahoo! UK Ltd, Case C-604/10 (European Court of Justice, 2012); Andreas Rahmatian, *Originality in UK Copyright Law: The Old "Skill and Labour" Doctrine Under Pressure*, 44 INT'L REV. INTELL. PROP. & COMPETITION L. 4, 6 (2013) (arguing that it is not clear how much EU law has changed U.K. law).

113. Various decisions regarding maps follow a similar analysis. *See, e.g.*, Kern River Gas Transmission Co. v. Coastal Corp., 899 F.2d 1458, 1463–64 (5th Cir. 1990) ("[T]he idea of the location of the pipeline and its expression embodied in the 1:250,000 maps are inseparable and not subject to protection."); Sparaco v. Lawler, Matusky, Skelly, Eng'rs LLP, 303 F.3d 460, 467 (2d Cir. 2002) (denying copyright protection to the portion of an architectural drawing setting forth mere factual information about the building site and using "standard cartographic features without originality"). *See also* Symposium, *Copyright in Electronic Maps*, 35 JURIMETRICS J. 395 (1995) (noting that the *Feist* decision leaves many digital maps unprotected by copyright); David B. Wolf, *Is There Any Copyright Protection for Maps After* Feist*?* 39 J. COPYRIGHT SOC'Y U.S.A. 224 (1992) (noting that the *Feist* decision leaves many digital maps unprotected by copyright).

114. Any views or labels that might exist in the design drawing are typically stripped away when the STL file is created. Further, changes made to ensure that the design file is water tight for 3D printing are done for utilitarian reasons, and are often automatically performed by a computer.

115. I do not mean to contend that simply saving a file in a different format would normally affect copyrightability. A document prepared in Word is just as copyrightable in Word Perfect. Rather, the transformation from design file to manufacturing-ready file can sometimes actually remove creative expression. For example, design files can include color, but the conversion to some types of manufacturing-ready files removes all color. The systematic removal of creative expression eventually would

choices.[116] To the extent that such creative choices pass the low *Feist* threshold and do not merge with the drawing's function, the drawing would be protected by copyright.[117] Of course, many of these accoutrements are unneeded for a design drawing to be used for digital manufacturing; they are only helpful to drawings that humans will view. Thus, courts will need to distinguish between those drawings with copyrightable expression (e.g., those with added information, creatively applied, and meant for human viewing) and those without. There is no way to generalize how copyright law will apply to all design drawings—the analysis will be fact-specific. Although this may lead to uncertainty for drafters and would-be downstream users alike, this is a feature common in copyright law. It can be said with some confidence, however, that design files created specifically for digital manufacturing will not usually include many of the creative aspects of traditional paper design drawings created for human consumption.

2. Technical Drawings as Encompassing the Artist's Personal Impressions

In addition, design drawings might be copyrightable under the theory positing that an artist who attempts to create realistic sketches and paintings of real-world objects necessarily imparts some independent creation to the work even though he tries to depict it exactly as it exists in nature.[118] Justice Holmes famously opined that even very realistic drawings always include a "personal reaction of an individual upon nature," thus rendering the drawing copyrightable.[119] In theory, this reasoning might apply to some CAD drawings if the draftsperson truly drafted in freehand. But in practice, it is absurd. Creativity is anathema to technical drawings of objects. To the extent the draftsperson drafts the object with creativity, he or she ceases to draft a *technical* drawing.

Further, CAD files are rarely drawn "from scratch" in the sense of the user drawing every line as one would draw with a pencil. Rather,

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leave any work without protection; consider removing words from a sonnet until nothing is left but one word.

116. *See, e.g.*, Axxiom Mfg., Inc. v. McCoy Invs., Inc., 846 F. Supp. 2d 732, 748 (S.D. Tex. 2012) (holding that a CAD drawing showing an exploded view of a valve contained enough non-merged creativity).

117. Many CAD programs have a default labeling and view scheme. For example, the program might automatically generate a top, side, and isometric view of the object, label some dimensions, generate a bill of materials, and add labels to each part. If the user blithely adopts these default settings, they cannot be the basis of any creativity on the part of the user. On the other hand, the user can choose to add or modify these parameters, such as by adding an additional, "zoomed-in" view of a specific portion of the object or to add a few extra dimension labels and perhaps some textual notes. These user-generated choices may satisfy the creativity threshold.

118. *See* Edward Lee, *Digital Originality*, 14 VAND. J. ENT. & TECH. L. 919, 938 (2012); *Of PhDs, Pirates, and the Public*, *supra* note 58, at 827.

119. Bleistein v. Donaldson Lithographing Co., 188 U.S. 239, 249–50 (1903).

the CAD software has numerous pre-stored shapes. For example, to draw a screw, a user simply selects a screw from the menu of pre-stored shapes and then specifies the screw's thread height, etc. Similarly, a drafter does not draw a circle the same way he or she would with a pencil. Instead, the drafter selects the "circle" shape option and then specifies a diameter. Thus, the automated and computer-controlled aspects of many CAD drawings of utilitarian objects will lack any "personal reaction of an individual upon nature," and as such will not contain any such inherent creativity in the copyright sense.

3. Technical Drawings Analogized to Typeface

A helpful analogy can be drawn between digital manufacturing files and digital files for typeface (e.g., Times New Roman or Arial fonts).[120] Generally, typefaces are not copyrightable because they are functional. There is an argument that some typefaces – as typefaces – have separable creative aspects (think of ornate flourishes surrounding letters),[121] but Congress has seemingly foreclosed this discussion[122] (and in any event, ornate typeface would not be analogous to purely utilitarian objects). With the digitization of typefaces, arguments arose that the computer programs for displaying the typefaces were copyrightable. Of course, computer programs for *designing* typefaces were copyrightable just like most other programs, but the "programs" for *displaying* the typefaces were more problematic because they were primarily simple data describing a given character.

The Copyright Office opined that early computer programs for displaying typefaces lacked copyright protection, at least in part because they lacked creativity.[123] Early digital font designers created bitmap

120. The Author thanks Aaron Perzanowski for referring me to the typeface literature. A typeface is "'a set of letters, numbers, or other symbolic characters, whose forms are related by repeating design elements consistently applied in a notational system and are intended to be embodied in articles whose intrinsic utilitarian function is for use in composing text or other cognizable combinations of characters.'" Jacqueline D. Lipton, *To © or Not to ©? Copyright and Innovation in the Digital Typeface Industry*, 43 U.C. DAVIS L. REV. 143, 148 (2009) (quoting Terrence J. Carroll, *Protection for Typeface Designs: A Copyright Proposal*, 10 SANTA CLARA COMPUTER & HIGH TECH. L.J. 139, 141 n.2 (1994)).

121. *See* Carroll, *supra* note 120, at 144–48.

122. H.R. Rep. No. 1476, 94th Cong., 2d Sess. 55 to 56 (1976), n. 88 ("The Committee has considered, but chosen to defer, the possibility of protecting the design of typefaces . . . . The Committee does not regard the design of typeface, as thus defined, to be a copyrightable 'pictorial, graphic, or sculptural work' within the meaning of this bill and the application of the dividing line in section 101."); Monotype Corp. PLC v. International Typeface Corp., 43 F.3d 443, 446 (9th Cir. 1994) (noting that "typefaces are not afforded copyright protection which has permitted popular typefaces originally developed by one to be easily and closely copied by a competitor without compensation").

123. Notice of Policy Decision on Copyrightability of Digitized Typefaces, 53 Fed. Reg. 38110 (Sept. 29, 1988) ("[T]he Copyright Office has decided that digitized representations of typeface designs are not registrable under the Copyright Act because

images of characters, which were essentially files that contained coordinates for a series of closely spaced dots (corresponding to pixels on a screen) that formed the character.[124] Programmers could create the image by scanning an existing character or by creating it from scratch.[125] One could create a letter from scratch by (1) bitmapping, that is, "building up an image bit-by-bit," (2) outlining, that is using lines or curves to define the boundaries of typeface characters, or (3) stroke defining, that is by drawing a curved or straight line on a computer screen.[126] The Copyright Office determined that none of these methods involved sufficient creativity because each was governed by the shape of a given character, which itself was not protectable.[127] In the Copyright Office's words, "the claim to copyright must exclude any data that ***merely*** depicts the typeface or letterforms" because "typefont data is determined by the ultimate shape of the typeface character, and requires de minimis, if any, selection and arrangement."[128]

As font programs developed, however, programmers created scalable fonts.[129] Thus, a program for a given letter no longer depicted a bitmap image of a particular character of a particular size (e.g. 12-point font, Times New Roman letter "A"). Instead, the file contained data for the outline of a letter and the means to scale that letter to different sizes. Of necessity, these letters were not stored as bitmapped images, but rather data points specifying edge points and distances between the points. The programs allowed the changing of the font size by manipulating those distances. Although the specification of edge coordinates sounds identical to the "outlining" method that the 1988 Policy Decision found insufficiently creative for copyright purposes, increased use of the outlining method coupled with the scalability convinced the Copyright Office to issue new regulations, which specified that programs for *scalable* fonts were copyrightable.[130]

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they do not constitute original works of authorship.") [hereinafter, 1988 Policy Decision].

124. *Id.* at 38110; Blake Fry, *Why Typefaces Proliferate Without Copyright Protection*, 8 J. TELECOMM. & HIGH TECH. L. 425, 438 (2010).

125. 1988 Policy Decision, *supra* note 123, at 38111.

126. *Id.*

127. *Id.* at 38112 ("The Copyright Office concludes that typefaces created by a computerized-digital process are also uncopyrightable. Like analog typefaces, digitally created typefaces exhibit no creative authorship apart from the utilitarian shapes that are formed to compose letters or other font characters.").

128. *Id.* (emphasis added). The Office continued, "Like analog typeface design, the design choices or any selection of data involved in the bitmapping, outlining, and stroke definition techniques are limited by the objective of rendering or fixing the uncopyrightable electronic font." Id.

129. Fry, *supra* note 124, at 438.

130. Final Regulation: Registrability of Computer Programs that Generate Typefaces, 57 Fed. Reg. 6201, 6202 (Feb. 21, 1992) [hereinafter, Regulation on Registrability] ("[T]he Copyright Office is persuaded that creating scalable typefonts using already-digitized typeface represents a significant change in the industry since our

The Copyright Office reasoned that "[f]or example, the creation of scalable font output programs to produce harmonious fonts consisting of hundreds of characters typically involves many decisions in drafting the instructions that drive the printer" and that "[t]he expression of these decisions is neither limited by the unprotectable shape of the letters nor functionally mandated."[131] The Office reiterated, however, that "digitized typeface as typeface is unregistrable."[132]

Applying the Copyright Office's reasoning to digital manufacturing files confirms that they are not copyrightable. The 1988 Policy Decision suggests that, as bitmapped images of non-protectable letters and numbers cannot receive copyright protection, neither can digital manufacturing files of non-protectable utilitarian objects. Both simply contain all the information needed to generate the non-protectable item. Likewise, the Copyright Office's 1992 regulation does not support granting copyright protection for digital manufacturing files of purely utilitarian objects. Unlike the font programs that contained creativity by generating scalable fonts defined by points, the creators of digital manufacturing files do not write code that makes their drawings scalable – the code that makes CAD drawings scalable is written by the CAD program creators. Thus, a pure digital manufacturing file of a utilitarian object, which is nothing more than a digitized utilitarian object, is equivalent to digitized typeface as typeface.

A few years after the Copyright Office's regulation, the U.S. District Court for the Northern District of California decided Adobe Systems, Inc. v. Southern Software, Inc.,[133] which provided protection for software that displayed characters. Interestingly, in contradistinction to the Copyright Office's 1992 regulation, the court did not emphasize font scalability, but rather the choices of coordinates for outlined characters. Adobe obtained digital character ("glyph") coordinate sets from third parties and then used software to translate those into an Adobe font coordinate system.[134] After translation, a person at Adobe would use a computer to "manipulate[ ] the on-curve and off-

previous Policy Decision."); see also 37 CFR § 202.1(e) (as amended Feb. 21, 1992); Fry, *supra* note 124, at 438; Jonathan L. Mezrich, *Extension of Copyrights to Fonts—Can the Alphabet Be Far Behind?*, 4 COMP. L. REV. & TECH. J. 62, 64 (1998).

131. Regulation on Registrability, *supra* note 130, at 6202. The Office was also greatly concerned with the administrative burden and public confusion that resulted from its 1988 requirement for applicants to disclaim copyright in the unprotected data. Thus, the Office determined to "amend its regulations to state its opinion that digitized typeface as typeface is unregistrable, and to delete the disclaimer requirement." *Id.*

132. *Id.* Thus, the Office never backed away from its determination that, e.g., mere bitmapped characters are not protectable, and characterized its regulation as "not represent[ing] a substantive change in the rights of copyright claimants." *Id.*

133. 45 U.S.P.Q.2d 1827 (BNA) 1831-32; 1998 U.S. Dist. LEXIS 1941 (N.D. Cal. 1998).

134. *Id.* at 1828.

curve of each displayed glyph altering its outline."[135] The purpose of the manipulation was to "efficiently, aesthetically and accurately render the appearance of each glyph."[136] The court held this to constitute sufficient creativity for copyright purposes, stating,

> there is some creativity in designing the font software programs. While the glyph dictates to a certain extent what points the editor must choose, it does not dictate every point that must be chosen. Adobe has shown that font editors make creative choices as to what points to select based on the image in front of them on the computer screen.[137]

The unpublished *Adobe Systems* decision involves an extremely close issue because the font editor exercised minimal creativity, if any, in selecting the coordinates. Indeed, the choices would seem to be arbitrary except that efficiency considerations dictated choosing as few points as possible and utilitarian considerations required selecting enough points to accurately portray the character.[138]

But even assuming the *Adobe Systems* decision is correct, it does not control the copyrightability of digital manufacturing drawings. Unlike the font designs in *Adobe Systems*, in which font editors selected only certain points along the curve, digital manufacturing file creators typically "draw" the entire object, not merely selected points of the object.[139] Thus, there is no potential creativity from the file creator based on a choice of select points along curves or lines—the creator "selects" all the points. The digital manufacturing file creator thus resembles the earliest "bitmap" digital font designers who digitized fonts by rendering verbatim the exact and entire shape of a given letter of a given size in a bitmap image.

C. *The File as a Literary Work*

The Copyright Act defines computer programs as "a set of statements or instructions to be used directly or indirectly in a computer in order to bring about a certain result."[140] All digital manufacturing files meet this definition because they contain instructions a computer uses to bring about a certain result, such as to display an image or control a 3D printer's nozzle. Any computer program can be repre-

135. *Id.* at 1828-29.

136. *Id.*

137. *Id.* at 1831.

138. In this regard, there is tension between *Adobe Systems* and the earlier discussed decision in *Meshwerks, Inc. v. Toyota Motor Sales U.S.A., Inc.*, 528 F.3d 1258 (10th Cir. 2008).

139. As discussed in the technical background in Section II, sometimes users will need to manually perfect STL files if there are "holes" in the object, but such repairs are entirely dictated by function (i.e., fill in the hole, completely). Often software repairs the files.

140. 17 U.S.C. § 101 (2017).

sented as text in a programming language, and thus may contain copyrightable expression as a literary work.[141]

Even with a technical programing language like the various GCODE languages, a programmer who directly writes in GCODE—rare though that may be—can write a program in slightly different ways to make the exact same utilitarian device.[142] For example, a programmer could choose to group several instructions on one line or could separate them into multiple lines.[143] Either way, the program would make the same object. Likewise, in some cases, the order of certain functions is immaterial. Imagine a CNC process that must drill two holes. It may make no difference whether the left or right hole is drilled first. Whenever a programmer can make creative choices in writing the software, there is a possibility that the resulting code is copyrightable as a literary work.[144]

The extent to which viewing code as a literary work has led to expansive copyright protection for software can be seen in the debate, discussed above, about the copyrightability of software code for typefaces. Although typefaces per se are not copyrightable in the United States,[145] courts and the Copyright Office have indicated that the code that generates a typeface may be copyrightable.[146] As Professor Jacqueline Lipton points out, however, "[m]uch digital font code may lack sufficient originality to attract copyright protection," because it

141. *See, e.g.*, Apple Comput., Inc. v. Franklin Comput. Corp., 714 F.2d 1240, 1253–54 ("We believe that the 1980 amendments reflect Congress' receptivity to new technology and its desire to encourage, through the copyright laws, continued imagination and *creativity* in computer programming.") (emphasis added); H.R. Rep. No. 94-1476, 54 (1976) ("'[L]iterary works' . . . includes . . . computer programs to the extent that they incorporate authorship . . . .") (emphasis added).

142. *G-Code*, WIKIPEDIA, https://en.wikipedia.org/wiki/G-code#Example_program [https://perma.cc/C3SL-QESD].

143. *Id.* ("There is room for some programming style, even in this short program. The grouping of codes in line N06 could have been put on multiple lines. Doing so may have made it easier to follow program execution.").

144. *See* 17 U.S.C. § 101 (2017); Apple Comput., Inc. v. Franklin Comput. Corp., 714 F.2d 1240, 1253–54 ("We believe that the 1980 amendments reflect Congress' receptivity to new technology and its desires to encourage, through the copyright laws, continued imagination and *creativity* in computer programming.") (emphasis added); H.R. Rep. No. 1476, 94th Cong., 2d Sess. 54 (1976) (stating that "'literary works' . . . includes . . . computer programs *to the extent that they incorporate authorship* . . . .") (emphasis added).

145. Eltra v. Ringer, 579 F.2d 294, 297–98 (4th Cir. 1978) (expressly excluding "typefaces as typefaces" from copyright protection) (citing Copyright Regulation § 202.10(c), 37 C.F.R. § 202.1(e) (1994)); H.R. Rep. No. 94-1476, at 55 ("The Committee does not regard the design of typeface . . . to be a copyrightable 'pictorial, graphic, or sculptural work' within the meaning of this bill and the application of the dividing line in section 101.").

146. Adobe Sys., Inc. v. S. Software, Inc., 45 U.S.P.Q. 2d 1827, (BNA) 1831–32 (N.D. Cal. 1998); 57 Fed. Reg. 6201, 6202 (Feb. 21, 1992) (codified at 37 C.F.R. pt. 202 (1994)) (indicating that the creation of font programs "typically involves many decisions in drafting the instructions that drive the printer" and thus may be registerable).

lacks creativity.[147] Importantly, she notes that many font designers "do not actually write code but instead use programs such as FontLab Studio or TypeTool to create typefaces, [and thus] may not create original code in the sense usually contemplated by copyright law."[148]

By analogy, the literal code of most digital manufacturing files will not embody any protectable originality or creativity. As with software that writes the typeface code based on a font editor's drawing, software that writes the digital manufacturing file code will remove the file creator from the literal code writing process. That is, the user draws the object in the CAD environment, allowing a predetermined algorithm to "write" the textual code. Presumably, the algorithm generating the code operates according to utilitarian principles and thus would not generate creative expression.[149] Similarly, the user typically relies solely on computer programs to convert the files to manufacturing-ready and machine-instruction files. If the user does not alter the file's automatically-generated code in any creative way, the file exhibits no creative expression. Rather, the file merely depicts an algorithmically determined, and presumably efficient, way to depict or manufacture the useful article.[150]

If one desires another analogy, consider that some photographs are not copyrightable because they lack creativity.[151] It would be absurd to say that the JPEG version of the non-copyrightable photo is copyrightable because a JPEG file constitutes software and is viewable as code. It is true that the JPEG file is software under the statute's capacious definition, but that does not make the file copyrightable as a literary work. The file is created by an algorithm embedded in whatever digital camera the photographer used, and since the photograph contains no creativity, neither does the code. Likewise, that a programmer could code the exact same JPEG file by hand does not make the photograph (or the JPEG copy of it) copyrightable.

147. Lipton, *supra* note 120, at 173.

148. *Id.*

149. If the resulting code contained creative expression resulting from the algorithm, the CAD software creator might be the owner of the copyright. *See* Grimmelmann, *supra* note 57, at 409–12.

150. *Of PhDs, Pirates, and the Public*, *supra* note 58, at 825–26 (noting that typically the code of a digital design file corresponds exactly with the utilitarian instructions to the manufacturing machine). *See also* Comput. Assocs. Int'l. v. Altai Inc., 982 F.2d 693, 708 (2d. Cir. 1992) (stating the elements dictated by efficiency are not creative, but rather utilitarian and thus not protectable expression).

151. *See, e.g.*, Bridgeman Art Library, Ltd. v. Corel Corp., 36 F. Supp. 2d 191 (S.D.N.Y. 1999); Schrock v. Learning Curve Int'l, Inc., 586 F.3d 513, 519 (7th Cir. 2009) (recognizing that there exists a "narrow category of photographs that can be classified as 'slavish copies,' lacking any independently created expression"). *Cf.* Daniel J. Gervais, Feist *Goes Global: A Comparative Analysis of the Notion of Originality in Copyright Law*, 49 J. COPYRIGHT SOC'Y U.S.A. 949, 971–72 (2002) ("[A] photographer trying to take a technically perfect picture is not making creative choices."); Justin Hughes, *The Photographer's Copyright—Photograph as Art, Photograph as Database*, 25 HARV. J. L. & TECH. 339, 374–75 (2012).

Turning away from photographs and back to digital manufacturing files, one may argue that creative decisions might be found in the order of the manufacturing process (e.g., drill the left hole first or start manufacturing on the left side of the object) or the order in which the user drew the parts. If the code internalizes the order chosen by the user, or if the user types the code directly, the code may reflect some designer choice.[152]

Even where such decisions exist and are reflected in the code, they do not likely overcome the hurdle of a "modicum of creativity," low though it may be.[153] Were it otherwise, simple recipes (as mere listings of ingredients) would be copyrightable because one could rearrange the list in multiple ways. But recipes as mere lists of ingredients are not copyrightable.[154] Further, even inclusion of simple instructions for mixing the ingredients does not make the recipe copyrightable because it is merely a functional system or process.[155]

152. Note that such choices are not likely carried over into the manufacturing-ready or machine-instruction files, which will be printed from the bottom up, regardless of the order in which the parts were drawn. And what constitutes the "bottom" is usually determined by utilitarian concerns.

153. Feist Publ'ns, Inc., v. Rural Tel. Serv. Co., 499 U.S. 340 (1991); Toro Co. v. R & R Prods. Co., 787 F.2d 1208 (8th Cir. 1986) (holding that arbitrarily assigned parts numbers lacked sufficient originality); Secure Servs., Inc. v. Time & Space Processing, 722 F. Supp. 1354, 1362–63 (E.D. Va. 1989) (holding that a manufacturer of facsimile machines did not include copyrightable expression in its digital handshake protocol as a derivative work of an industry protocol even though it could "vary specific bits within certain signals" because "[s]uch minor reordering or variance of binary signals does not rise to the level of copyrightable material" and because "[t]o grant a copyright to a mere rearrangement of binary digits would effectively eliminate any authorship or originality requirement from the copyright laws."). Frankly, however, one can cite just as many cases supporting the opposite view. *See, e.g.*, Hughes, *supra* note 10, at 581–604. Some of the varied application of the "creativity" requirement can be explained by copyright law's historical ontological fixations. *See* Lloyd L. Weinreb, *Copyright for Functional Expression*, 111 HARV. L. REV. 1150, 1184–210 (1998).

154. 37 C.F.R. § 202.1(a) (West, Westlaw current through Mar. 23, 2017) (stating that "mere listing of ingredients or contents" are not copyrightable).

155. *See* Publ'ns Int'l. v. Meredith, 88 F.3d 473, 480–81 (7th Cir. 1996) ("The identification of ingredients necessary for the preparation of each dish is a statement of facts . . . . We do not view the functional listing of ingredients as original within the meaning of the Copyright Act . . . . The recipes at issue here describe a procedure by which the reader may produce many dishes featuring Dannon yogurt. As such, they are excluded from copyright protection as either a 'procedure, process, [or] system.'"); Lambing v. Godiva Chocolatier, No. 97-5697 (6th Cir. Feb. 6, 1988); Tomaydo-Tomahhdo, LLC v. Vozary, 629 Fed. Appx. 658, 661 (6th Cir. 2015) ("Here, the recipes themselves do not enjoy copyright protection. The list of ingredients is merely a factual statement, and as previously discussed, facts are not copyrightable. Furthermore, a recipe's instructions, as functional directions, are statutorily excluded from copyright protection.") (citations omitted); Lapine v. Seinfeld, 2009 WL 2902584 (S.D.N.Y. Sept. 10, 2009). Of course, recipes imbued with creative prose can enjoy copyright protection in the prose. *Meredith*, 88 F.3d at 481 ("There are cookbooks in which the authors lace their directions for producing dishes with musings about the spiritual nature of cooking or reminiscences they associate with the wafting odors of certain dishes in various stages of preparation.").

In any event, utilitarian constraints will circumscribe most potentially creative decisions,[156] rendering the resulting order non-protectable.[157] Further, in the majority of cases, computer programs create the manufacturing-ready and machine-instruction files from design files, and the program dictates the order of operations based on utilitarian, not creative, rules. In short, manufacturing-ready and machine-instruction files simply show an exact representation of the utilitarian object as needed to manufacture it (and, in the case of some GCODE depictions, the functional machine tool path).

Alternatively, such trivial choices represent one of but a few ways to order the manufacturing options, and thus the choices merge with the utilitarian function.[158] Hence, while it is theoretically possible for digital manufacturing files to contain copyrightable expression in their executable code, such instances will be rare. Nevertheless, to the extent that such choices constitute creative expression that does not merge with the idea of the file, the literary work contained in the file could be protected by copyright.

D. *The File as a Compilation*

Thus far this Article has assumed the relevant file contains a single utilitarian object (even if that object has multiple parts, which is not a problem for 3D printers). It is possible, however, for multiple, separate utilitarian objects to exist within a single file. A creator can include as many separate objects as will fit in a 3D printer's build volume. Thus, the user could arrange one screw, one gear, and one nozzle in a single file, which could then be 3D printed in one pass.

156. For example, one would generally print a bottle from the bottom up, rather than building it sideways from the left side to the right, because sideways printing presents structural difficulties and results in a weaker object. Thus, the "order" of 3D printing an object in a single pass is likely entirely dictated by functional considerations. For CNC and laser cutting processes, the author's research did not divulge whether any choices, such as the order of drilling holes, that might have been included in the design file is transferred to the manufacturing-ready or machine-instruction files. In other words, if the user "draws" the left hole first and then the right hole, it is not clear that the later files will retain that information or instead perform the drilling order according to a predetermined algorithm (e.g., always left to right). Regardless, such choices likely lack a modicum of creativity.

157. *See, e.g.*, Mid Am. Title Co. v. Kirk, 59 F.3d 719, 722 (7th Cir. 1995) (holding that a compilation of land title data lacked creativity because the selection of data was a "matter of convention and strict industry standards"); Eng'g Dynamics, Inc. v. Structural Software, Inc., 26 F.3d 1335, 1346–47 (5th Cir. 1994) (ordering remand to determine "whether or to what extent industry demand and practice in the offshore engineering market dictated the [computer program's] input and output formats").

158. *See* Comput. Assocs. Int'l. v. Altai Inc., 982 F.2d 693, 708 (2d. Cir. 1992) (holding that the idea embodied in a computer program's subroutine merges with the expression when "efficiency concerns . . . so narrow the practical range of choice as to make only one or two forms of expression workable options"); Morrissey v. Procter & Gamble Co., 379 F.2d 675, 678–79 (1st Cir. 1967) (holding that any expression embodying the rules of a sweepstakes contest was inseparable from the idea of the contest itself, and therefore the instructions were not protectable by copyright).

With multiple objects in a single file, the work could be considered a compilation, which is "a work formed by the collection and assembling of preexisting materials or of data that are selected, coordinated, or arranged in such a way that the resulting work as a whole constitutes an original work of authorship."[159] By including the phrase "original work of authorship," the definition of a compilation retains the requirement of creativity.[160] By selecting, coordinating, or arranging the various objects included in the single file, a user might create an "original work of authorship."[161] On the other hand, unlike copyrightable selections of data included in tables, here the file is not meant to be consumed as a drawing or other work. Rather, the decision whether and how to include multiple parts might be arbitrary or driven largely by function: is it advantageous to print them at the same time, will they all fit into the build volume, and are they arranged in a way that maximizes print strength? As such, the file might not contain a modicum of creativity.[162] Coincidentally, the Copyright Office unwittingly anticipated a surprisingly similar claim, stating that "the Of-

159. *See* 17 U.S.C. § 101 (2017). Note that a digital manufacturing file of a single object could be considered a compilation. *See* Gemel Precision Tool Co., Inc. v. Pharma Tool Corp., 25 U.S.P.Q.2d 1019; 1995 WL 71243 (E.D. Pa. 1995) (treating CNC machine computer files as databases, but without discussion as to whether they are more accurately categorized as a program). But the files are better understood to be programs. Regardless, for the same reasons as stated previously, there is no creativity as to the selection and arrangement of the data in digital manufacturing files for purely utilitarian objects.

160. Feist Publ'ns, Inc. v. Rural Tel. Serv. Co., 499 U.S. 340 (1991).

161. Publ'ns Int'l v. Meredith, 88 F.3d 473, 480 (7th Cir. 1996) ("The identification of ingredients necessary for the preparation of each dish is a statement of facts . . . . Instead, he was writing down an idea, namely, the ingredients necessary to the preparation of a particular dish . . . . We do not view the functional listing of ingredients as original within the meaning of the Copyright Act.")

162. *See* Tomaydo-Tomahhdo, LLC v. Vozary, 629 Fed. Appx. 658, 661 (6th Cir. 2015) ("Despite their arguments, Tomaydo does not point to anything demonstrating that the recipe book is an original compilation. While Tomaydo stresses that they purposefully selected and arranged the menu items, Tomaydo never identifies what is original and creative about their process."); Toro Co. v. R & R Prods. Co., 787 F.2d 1208 (8th Cir. 1986) (holding that arbitrarily assigned parts numbers lacked sufficient originality). It is worth noting that the law is inconsistent in its treatment of compilations. *Compare* CCC Info. Servs. v. Maclean Hunter Mkt. Reports, Inc., 44 F.3d 61 (2d. Cir. 1994) (granting copyright protection to plaintiff's "Red Book" that listed used car price estimates because there was sufficient creativity in the selection of optional car features and number of years' models to be included in a used-car price compilation); Am. Dental Ass'n v. Delta Dental Plans Ass'n, 126 F.3d 977, 979 (7th Cir. 1997) (extending protection to compilation of numeric designations of dental procedures) *with* ATC Distrib. Grp., Inc. v. Whatever It Takes Transmissions & Parts, Inc., 402 F.3d 700, 708–12 (6th Cir. 2005) (disapproving of ADA v. Delta Dental and refusing to grant protection to taxonomy and compilation of auto part numbers). The ATC court based its refusal to grant protection in the compilation in part on the fact that the plaintiff largely copied its compilation from another compilation.

fice will not register a work in which the claim is in . . . a 'selection and arrangement of handtools.'"[163]

E. *The File as a System, Process, or Method*

It is possible to view a digital manufacturing file (especially a manufacturing-ready file or machine-instruction file), as a system, process, or method and thus non-copyrightable under Section 102(b).[164] The argument has appeal, as it does with every piece of software, because software is a series of steps—that is, a method. But that argument is too facile because Congress clearly intended at least some software to be copyrightable.[165]

Because Congress manifestly indicated that software can be protectable, at least as a literary work, attempting to label a digital manufacturing file as a system, process, or method leads one right back to the issue of whether the file contains a modicum of creativity. Here again, the files can be analogized to recipes, whose instructions have been held not copyrightable because they are a system.[166] What the courts mean when holding that recipe instructions are not copyrightable is that they are utilitarian and contain insufficient creativity apart from their function.[167] Surely the instruction "mix ingredient A with ingredient B" is utilitarian and contains no protectable creativity, whereas the instruction, "steady your excited hand if you can (I know you are excited to cook) and grasp with gusto ingredient A . . . break a smile and twirl around as you begin to intermingle, ever so joyfully,

163. 37 C.F.R.Part 201, https://www.regulations.gov/document?D=COLC-2012-0011-0001 [https://perma.cc/AX84-SUWN]; Compendium, §312.1, https://www.copyright.gov/comp3/chap300/ch300-copyrightable-authorship.pdf [https://perma.cc/J33V-3PXL].

164. 17 U.S.C. § 102(b) (2017) ("In no case does copyright protection for an original work of authorship extend to any idea, procedure, process, system, method of operation, concept, principle, or discovery, regardless of the form in which it is described, explained, illustrated, or embodied in such work.").

165. *See* Pub. L. No. 96-517, 94 Stat. 3015 (codified at 17 U.S.C. §§ 101, 117 (1980)). *See also* Pamela Samuelson, *Functionality and Expression in Computer Programs: Refining the Tests for Software Copyright Infringement*, draft at 16 (Sep. 30, 2015), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2667740 [https://perma.cc/8CSV-YSEU] ("The least controversial proposition about § 102(b) in relation to computer programs is that Congress could not possibly have intended courts to give a completely literal interpretation to § 102(b) because this would render programs ineligible for copyright protection.").

166. *See* 37 C.F.R. § 202.1(a) (West, Westlaw current through Mar. 23, 2017) (stating that "mere listing of ingredients or contents" are not copyrightable).

167. *Cf.* Christopher Buccafusco, *On the Legal Consequences of Sauces: Should Thomas Keller's Recipes Be Per Se Copyrightable?*, 24 CARDOZO ARTS & ENT. L.J. 1121, 1131 (2007) ("To say that a recipe is an uncopyrightable procedure or process is the same as saying that a schematic rendering of dance steps is a procedure or, more clearly, that the required instruments and notes for a symphony constitute a process."). Of course, as Professor Buccafusco recognizes, the difference between musical notes and recipes is that music constitutes a copyrightable work and a dish of food does not.

ingredient A with ingredient B" would at least entertain the hope of being found sufficiently creative.

In short, attempting to label the file a "system, method, or process" simply recognizes the utilitarian aspects of the file. But it does not end the analysis.

F. *Summary*

In conclusion, routine manufacturing-ready and machine-instruction files likely contain no creative aspects. Design files may contain some creative aspects, particularly as technical drawings if they contain creatively arranged information in addition to pure manufacturing information, but will need to be judged on a case-by-case basis.

Finally, it is important to note that even where design files are protected by copyright, nothing prevents a third party from independently developing a design file for the exact same utilitarian object. As Justice Holmes stated, "[o]thers are free to copy the original [if it is not protected by copyright]. They are not free to copy the copy."[168] Furthermore, any rights in a technical drawing do not extend to the right to manufacture the utilitarian object depicted therein.[169] Thus, a third party is free to create the same design file from scratch, even if they are using the output of the protected version as a reference.

This entire analysis, however, must be tempered by the fact that a user can easily add superfluous, but creative material to any digital manufacturing file in an attempt to make an otherwise non-copyrightable file copyrightable. The Author discusses this possibility in Section V.

V. IMPORTANT CAVEATS: CREATIVITY AND LOCK-OUT CODES

The previous Section's analysis demonstrated that many digital manufacturing files depicting purely utilitarian articles will likely not enjoy copyright protection. Of course, by limiting the discussion to files of *purely* utilitarian objects, the discussion avoided two obvious instances where the files might enjoy intellectual property protection.[170] First, files of objects that have physically or conceptually separable copyrightable elements—like the lamp base in *Mazer v. Stein*[171]—can enjoy copyright protection. Second, if the underlying ob-

168. Bleistein v. Donaldson Lithographing Co., 188 U.S. 239, 249 (1903).

169. 17 U.S.C. § 113(b) (2017) ("This title does not afford, to the owner of copyright in a work that portrays a useful article as such, any greater or lesser rights with respect to the making, distribution, or display of the useful article so portrayed than those afforded to such works under the law, whether title 17 or the common law or statutes of a State, in effect on December 31, 1977, as held applicable and construed by a court in an action brought under this title.").

170. *See* Timothy R. Holbrook & Lucas S. Osborn, *Digital Patent Infringement in an Era of 3D Printing*, 48 U.C. DAVIS L. REV. 1319 (2015).

171. Mazer v. Stein, 347 U.S. 201, 202 (1954).

ject contains ornamental design protectable under the design patent regime,[172] the file as depicted on a computer screen might likewise be protectable with a design patent.[173]

Within the category of files for purely utilitarian objects, however, two big caveats demand attention. First, users can insert non-executable comments into the text of any file and that text can enjoy copyright protection. Second, users can include copyrightable images or other material within a digital manufacturing file for a utilitarian object. Either scenario will render the file as a whole potentially protected by copyright and may thus limit the public's access to utilitarian, non-copyrightable aspects of the files.

A. *Comments and Creative Images as Lock-Out Codes*

As discussed, all three types of digital manufacturing files can be represented textually in a programming language. Much, if not all, of this text lacks creativity because it is geared toward efficiently producing a purely utilitarian object and because the user typically does not write the code, but only draws shapes. All the files, however, can include non-executable comments. Comments are language in the program that the computer does not run or execute when reading the file. Most programming languages have one or more characters that denote the start of a comment, such as the semi-colon in many GCODE languages. Here is a short excerpt of GCODE for a simple washer containing comments:

172. 35 U.S.C. § 171(a) (2012).

173. *See, e.g.*, Graphical user interface for a display screen of a commc'ns terminal, U.S. Patent No. D599,372 (granting protection for design as depicted on a computer screen). Design patents can only be awarded for "any new, original and ornamental design for an article of manufacture" 35 U.S.C. § 171(a) (2012). Although the patent office has issued many design patents for items displayed on a computer screen (e.g., smart phone icons), no published case has upheld the validity of any of these design patents as a "design *for* an article of manufacture."

```
G1 Z15.0 F9000 ;move the platform down 15mm

G92 E0                  ;zero the extruded length
G1 F200 E3              ;extrude 3mm of feed stock
G92 E0                  ;zero the extruded length again
G1 F9000
;Put printing message on LCD screen
M117 Printing...

;Layer count: 12
;LAYER:0
M107
G0 F9000 X58.549 Y59.387 Z0.300
;TYPE:SKIRT
G1 F1800 X59.715 Y58.239 E0.03847
G1 X60.945 Y57.153 E0.07706
G1 X62.234 Y56.138 E0.11563
G1 X63.575 Y55.196 E0.15417
G1 X65.099 Y54.246 E0.19639
```

Everything that follows a semi-colon on a given line of code constitutes a non-executable comment. As can be seen, these comments often explain what the code is doing so that a second user can more easily follow the code. The comments can be hand typed by a user and can contain anything, including fanciful or creative text.

The comments in the example are minimal and may not constitute enough creativity to garner copyright protection.[174] Nevertheless, it is certainly conceivable that a file could contain extensive instructional comments that have copyrightable creativity. Moreover, a user who affirmatively wants to ensure the file contains copyrightable expression could easily add arbitrary creative text—perhaps an original haiku[175]—to the file. Alternatively, a designer may include a non-relevant creative image in the file by using the CAD program to overlay the utilitarian article with a creative pattern or picture, or he may put the picture off to the side but within the file.[176]

174. *See, e.g.*, Morrissey v. Procter & Gamble Co., 379 F.2d 675, 678 (1st Cir. 1967) (holding that any possible expression in a text describing the rules of a contest had "merged" with the idea because there were only a small, finite, and limited number of ways to express the idea of such a contest).

175. A company embedded an original haiku into the header of outgoing emails of its clients to prevent those emails from being tagged as spam by email programs and threatened to sue for copyright infringement any other company who used the haiku without permission. *See, Habeas Haiku Splatters Spam*, INTABULLETIN (July 1, 2003), http://www.inta.org/INTABulletin/Pages/HabeasHaikuSplattersSpam.aspx [https://perma.cc/T7HH-LP9L]; *see also*, John Leyden, *Habeas Sues Haiku Abusers: Allegations Of Counterfeit And Spamming*, THE REGISTER (Apr. 4, 2003, 3:51 PM), http://www.theregister.co.uk/2003/04/04/habeas_sues_haiku_abusers/ [https://perma.cc/G8XQ-48CK].

176. *See* Dagne & Dubeau, *supra* note 60, at 115 ("A design of a coffee mug may have a decorative flourish added to the handle, or pattern added to the face. This final touch of personalization can easily transform a purely functional object into something over which copyright may apply. It is easy to pull this design into the realm of protection."). Putting a creative image in a design file might protect the design file,

Because a file generally must be copied in whole, a second user generally could not copy the file without violating the copyright in the arbitrary creative content. Even though the copier does not want or care about the creative text, she generally must copy the entire file to get the desired executable portion. This creates a dilemma for people who want to copy only the non-protectable aspects of a file but have no way to do so.

In many of these situations, the copyrightable expression is completely ancillary to the utilitarian feature of the file and acts simply as a type of lock-out code.[177] No one values this type of file for its creative expression; people only want the functional features. In these instances copyright law is not protecting the value of the creative work, but is protecting the value of a utilitarian work. In short, the creator has utilized copyright law to prevent access to utilitarian material.

B. *Patent and Copyright Boundaries*

The use of copyright law to bar access to utilitarian aspects of a digital manufacturing file gives rise to doctrinal and normative questions. This debate in many ways mirrors the debate about the appropriate intellectual property protections for software generally, which recognized that software was primarily functional in nature.[178] The Author will leave the normative questions for future work and will outline various doctrinal approaches that courts might apply where a second user wants to copy a digital manufacturing file to copy the utilitarian contents. The Author will assume that the copier has no rea-

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but the image may not translate into the manufacturing-ready or machine-instruction file, depending on the format. Many STL files do not include color or surface patterns, but other manufacturing-ready formats can, such as 3MF and AMF. *See* http://3daddfab.com/blog/index.php?/archives/4-What-is-an-STL-file-and-is-it-obsolete.html [https://perma.cc/5GT7-P3G6] ("STL files contain only vertex and facet definitions. Not even units are a part of a standard STL file, let alone material or color definitions.").

177. *Cf.* Julie E. Cohen, *Reverse Engineering and the Rise of Electronic Vigilantism: Intellectual Property Implications of "Lock-Out" Programs*, 68 S. CAL. L. REV. 1091, 1094–97 (1995) (discussing lock-out programs that limit access to video games without a key, wherein the key consists of copyrighted material); Andrea Pacelli, *Who Owns the Key to the Vault? Hold-up, Lock-out, and Other Copyright Strategies*, 18 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 1229, 1242–46 (2008) (discussing the use of copyrighted material as a password for access to a computer program or other proprietary source). The use of copyrightable material in a digital manufacturing differs in one way from many other instances of lock-out codes. Most lock-out codes occur in the context of interoperability, such as where two pieces of non-copyrightable hardware will not interface without the lock-out code. Circumventing a lockout code in the hardware context does not permit cost-free, instantaneous copying of the hardware. The competitor must build its own hardware. With digital manufacturing files, unlocking the code allows instant, cost-free copying of the file. Cost-free copying in the digital manufacturing context may alter the normative desirability of lock-out codes.

178. *See, e.g.,* Menell, *supra* note 9; Oddi, *supra* note 9; Samuelson et al., *supra* note 9.

sonable way to obtain the utilitarian portion without copying the entire file, including any incidental copyrightable expression.[179]

One response is for courts to simply allow this use of copyright law as a way to protect the creator's "sweat of the brow" in creating the utilitarian work or to otherwise prevent "free-riding." The Supreme Court has rejected a sweat of the brow doctrine as a means to convey copyrights in non-expressive works,[180] but has not opined on the propriety of allowing copyrightable expression to serve as a lock-out mechanism to a utilitarian work. In endorsing such uses, a court could find that they do not operate as true lock-out codes because third parties can independently create the same utilitarian digital file (minus the copyrighted expression) from scratch, at least where they are copying a physical object.[181] The availability of independent creation—even using the first creator's physical output as a reference—suggests that copyright law's trespass into patent law is not wholesale. But this ignores situations where, due to exacting tolerances, it may be difficult or impossible to recreate an identical part by working backward from an existing product.[182]

Courts disapproving of these lock-out codes have several tools at their disposal. In some cases, the court could decide that the lock-out tool was so basic that it lacked creativity and thus is not copyrightable.[183] Creators would, however, simply respond to this possibility by lengthening the expression and imbuing it with more creativity.[184] Courts could also decide that because the expression functions as a lock-out code, any expression merges with its function.[185] Under the

179. For this analysis, the Author will assume that the file is not protected by a patent and will not consider the option of paying for the copy—the whole point of the copyright analysis is to tell us whether one must pay for something she could otherwise copy for free.

180. Feist Publ'ns, Inc. v. Rural Tel. Serv. Co., 499 U.S. 340, 353 (1991).

181. Bleistein v. Donaldson Lithographing Co., 188 U.S. 239 (1903); 17 U.S.C. §113(b) (2017). Section 113(b) speaks directly to the manufacture of a utilitarian object from a copyrighted drawing, but does not directly address the creation of an independent *drawing*. *See* Nat'l Med. Care, Inc. v. Espiritu, 284 F. Supp. 2d 424, 433–38 (S.D.W. Va. 2003). *Bleistein*, however, more directly addresses creating an independent drawing by copying the physical object.

182. *See* Rockwell Graphic Sys., Inc. v. DEV Indus. Inc., 925 F.2d 174, 175 (7th Cir. 1991) (noting the importance of tolerances in machine part manufacturing).

183. *See Circular 34: Copyright Protection Not Available for Names, Titles, or Short Phrases*, U.S. COPYRIGHT OFFICE (Oct. 2015), http://www.copyright.gov/circs/circ34.pdf [https://perma.cc/AWD4-XKBU] (stating that short phrases are not copyrightable).

184. Karl Llewellyn was famously critical of "covert tools" courts use, such as misconstruing contract language to reach a desired result, in part because future lawyers would "recur to the attack" and draft language that would be clearer and more difficult to misconstrue. KARL LLEWELLYN, THE COMMON LAW TRADITION, 364–65 (1960).

185. *Cf.* Lexmark Intern., Inc. v. Static Control Components, Inc., 387 F.3d 522, 541 (2004) ("[T]he fact that [the expression] also functions as a lock-out code undermines the conclusion that Lexmark had a probability of success on its infringement claim.").

extreme version of this rationale, any expression, no matter how extensive and creative, cannot enjoy copyright protection when used as a lock-out code.[186]

Another avenue to disentangle copyright law and patent law would be for courts to permit the copying of at least some files under a fair use rationale.[187] Fair use requires the balancing of several factors to determine whether a defendant can be excused from infringement.[188] Courts apply fair use in the context of computer programs to preserve "public access to the ideas and functional elements embedded in copyrighted computer software programs."[189] Courts have suggested that fair use can excuse the copying of lock-out codes.[190]

Finally, courts opposing lock-out mechanisms could declare that the use of copyrightable expression solely as a lock-out mechanism constitutes copyright misuse.[191] Copyright misuse is an equitable doctrine and typically involves anti-competitive behavior that violates antitrust

186. *Id.* at 544 ("[A] poem in the abstract could be copyrightable. But that does not mean that the poem receives copyright protection when it is used in the context of a lock-out code."). *Cf.* Secure Servs., Inc. v. Time & Space Processing, 722 F. Supp. 1354, 1362–63 (E.D. Va. 1989) (holding that a manufacturer of facsimile machines could not copyright its digital handshake protocol as a derivative work of an industry protocol).

187. *See* Lexmark, 387 F.3d at 544–45.

188. 17 U.S.C. § 107 (2017) (listing as non-exclusive factors: "(1) the purpose and character of the use, including whether such use is of a commercial nature or is for nonprofit educational purposes; (2) the nature of the copyrighted work; (3) the amount and substantiality of the portion used in relation to the copyrighted work as a whole; and (4) the effect of the use upon the potential market for or value of the copyrighted work").

189. Sony Comput. Entm't, Inc. v. Connectix Corp., 203 F.3d 596, 603 (9th Cir. 2000).

190. *See* Lexmark, 387 F.3d at 544–45. *Cf.* Sega Enters. Ltd. v. Accolade, Inc., 977 F.2d 1510, 1520–28 (9th Cir. 1992) (finding intermediate copying to understand video game compatibility with game console to be per se fair use); Connectix, 203 F.3d at 602–08 (finding that intermediate copying of BIOS that was necessary to access unprotected functional elements of video game console constituted fair use); Chamberlain Grp., Inc. v. Skylink Techs., Inc., 381 F.3d 1178 (2004) (refusing to allow a DMCA claim to eviscerate a fair use defense); Julie E. Cohen, *Reverse Engineering and the Rise of Electronic Vigilantism: Intellectual Property Implications of "Lock-Out" Programs*, 68 S. CAL. L. REV. 1091, 1104–51 (1995).

191. *See, e.g.*, Lasercomb Am., Inc. v. Reynolds, 911 F.2d 970, 979 (4th Cir. 1990) (extending copyright misuse to a license that required licensees to agree not to create competing software); Practice Mgmt. Info. Corp. v. Am. Med. Ass'n, 121 F.3d 516 (9th Cir. 1997); Alcatel USA, Inc. v. DGI Techs., Inc., 166 F.3d 772 (5th Cir. 1999) (extending copyright misuse to a license that required licensees to agree not to create competing software); Omega S.A. v. Costco Wholesale Corp., 2011 WL 8492716 (C.D. Cal. Nov. 9, 2011) (finding copyright misuse where Omega placed a copyrighted design on the back of its watches to control parallel importation of lawfully sold goods); Brett Frischmann & Dan Moylan, *The Evolving Common Law Doctrine of Copyright Misuse: A Unified Theory and its Application to Software*, 15 BERKELEY TECH. L.J. 865, 912 (2000) (arguing that "copyright misuse is an appropriate judicial mechanism for restricting the social costs of granting copyrights on functional innovations"); Kathryn Judge, Note, *Rethinking Copyright Misuse*, 57 STAN. L. REV. 901 (2005); Karen E. Georgenson, *Reverse Engineering of Copyrighted Software: Fair Use*

laws, but "[t]he question is not whether the copyright is being used in a manner violative of antitrust law . . . , but whether copyright is being used in a manner violative of the public policy embodied in the grant of a copyright."[192] Thus, courts could use copyright misuse to prohibit enforcing a copyright for a lock-out code in a digital manufacturing file.

One potential difficulty may be distinguishing between relevant creative content (i.e., that which genuinely explains aspects of the file to later users) and non-relevant content (i.e., that which a user adds solely to use copyright to control copying of the file). Of course, if the former is given copyright protection, those solely wanting control of their files will adapt to add copyrightable comments that look (and may be) relevant to downstream users. Attempting to ascertain a creator's intent will be futile. It may be that even protecting genuine content is not worth the candle. Or a balancing approach, such as fair use, may allow utilitarian uses, though perhaps at costs to ex ante certainty regarding freedom to use files. Based on the Author's discussions with 3D printing specialists, it appears that while design files might often have relevant non-executable comments, manufacturing-ready and machine-instruction files typically do not.

When considering the copyright tools at their disposal, courts should keep in mind the possibility of other protection mechanisms, including contract, branding, utility patents (for new and non-obvious inventions), and design patents (for new, ornamental designs of an articles of manufacture). For example, if the digital manufacturing file will create a patented, physical device, anyone who manufactures that device without permission will infringe the patent.[193] This offers some protection to the inventor, but various realities of utility patent law make it difficult to enforce a patent against digital representations of the device.[194] If patent law is insufficient to protect innovators, courts may be tempted to use copyright law as a substitute. Whether this is desirable can and should be debated, but the Author reserves such analysis for other work.[195]

VI. CONCLUSION

Digital manufacturing files can constitute copies of various copyrightable works. If the underlying physical object that the file will manufacture contains copyrightable expression, the file constitutes a protected copy. Although courts may be tempted to assume otherwise, many files of purely utilitarian objects will lack even the minimal

Or Misuse?, 5 ALB. L.J. SCI. & TECH. 291, 313 (1996) (supporting copyright misuse defense for necessary intermediate copying and any derivative uses).

192. Lasercomb, 911 F.2d at 978.

193. Holbrook & Osborn, *supra* note 170, at 1332.

194. *See id.* at 1332–69.

195. *See Intellectual Property Channeling*, *supra* note 11.

creativity needed to satisfy copyright law's originality requirement. Support for this bold assertion can be found in basic copyright principles as well as analogous precedent such as typeface font files, recipes, and digital copies of uncopyrightable photographs. If copyright law does not directly protect the files, creators will seek to employ lock-out codes—ancillary and unneeded copyrightable expression—in the files to attempt to garner copyright protection. Whether courts allow these lock-out codes to prevent verbatim copying of the files remains to be seen.