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COPYRIGHTS IN COMPUTER-GENERATED WORKS: WHOM, IF ANYONE, DO WE REWARD?

Computer-generated works raise grave authorship concerns under U.S. copyright law, with arguments in favor of allocating copyrights to the computer user, programmer, the computer itself, or some combination therein. The author discusses the issues and paradoxes inherent in these choices, and assesses the nature of mathematical graphical processes in light of the idea/expression dichotomy.

INTRODUCTION

¶ 1 Copyright law is continually re-modified, reevaluated and reinterpreted to adapt to a seemingly constant change in technology. A variety of amendments have been codified to accommodate the "Digital Age" and the Internet,¹ the increasingly complex battle for recording, distribution and reproduction rights in sound recordings,² and the relatively new area of computer programs.³ These amendments, and perhaps the continuous judicial reinterpretation of the Copyright Act, are up to the mark when it comes to the newest technologies,⁴ in the newest settings,⁵ with one glaring exception: computer-generated works. Unmentioned in the current statute and relatively untreated in American jurisprudence, computer-generated works are finding themselves susceptible to uncertain protection with future litigation looming. Several theories exist in the current copyright system to answer the question of whom, if anyone, can assert exclusive rights in these works. However, it is unclear and somewhat doubtful whether contemporary theories of protection are suitable for computer-generated fractals and Mandelbrot Sets.

WHAT ARE FRACTALS?

¶ 2 Benoit Mandelbrot derived the term fractal from the Latin adjective *fractus*, meaning irregular or broken. Fractals can be used to describe intricately nested patterns within patterns, which contain self-similarity. Self-similarity is exhibited when a geometric figure is magnified over and over; upon each successive enlargement the fractal always resembles the original image. Furthermore, fractals can be recognized in a wide range of natural phenomena and shapes, including leaves, snowflakes and the human body.⁶

¶ 3 In the most generalized terms,⁷ a fractal demonstrates a limit of complex physical processes and dynamic systems. The fundamental premise of fractals is that basic natural processes become very complicated processes as the number of iterations approaches infinity. Examples of the underlying process are taking the square root or performing the natural logarithm of a set of inputs. Additionally, fractals are able to graphically represent models of complex processes by iterating the underlying simple processes.

¶ 4 Computer programmers can create a feedback loop using methods known as recursive algorithm and iterative functioning. After performing the mathematical operation on the data, programmers infinitely feed the result back into the loop; the limit of the process is the fractal. Rounding errors in the mathematical operation invariably lead to chaotic results in the graphical representation. After assigning a color-scheme to the fractal results, these errors are magnified and repeated, producing a completely unexpected result. First viewed in 1980, a Mandelbrot Set (a subset of fractals) completely characterizes quadratic functions, and has been called "one of the most intricate and beautiful objects in mathematics."⁸ Research into fractal theory and fractal geometry is a relatively new subject and has recently been used to measure the complexity of many objects.⁹

¶ 5 One interesting wrinkle of fractals, and one that further complicates the matter of copyright protection, is that they can have useful, industrial applications. For example, because the human body (which, at its core, is a simple process) can be represented by a fractal structure, fractal theory can be useful in x-ray analysis, tissue decomposition and preparatory surgical probing. In addition, the art of acupuncture has close links to fractal theory.¹⁰

WHAT IS THE PROBLEM?

¶ 6 As copyright law protects original works of "authorship" and grants exclusive rights to "authors," defining the author is of fundamental concern. There are five principle solutions to the problem of identifying an author in the realm of computer-generated art. A copyright in the computer-generated fractal can be assigned to 1) the computer programmer, 2) the user of the program, 3) both the programmer and the user, 4) the computer, or 5) no one.

¶ 7 While the United States has yet to define the author for computer-generated works, the United Kingdom has provided some guidance, albeit with amorphous terms,

In the case of a literary, dramatic, musical or artistic work which is computer-generated, the author shall be taken to be the person by whom the arrangements necessary for the

creation of the work are undertaken.¹¹

¶ 8 While a clear interpretation and application of this law is possible with most works that are computer-generated, England's Act does not provide obvious answers for computer-generated works as applied to Mandelbrot Sets and other fractal-generations. For example, while the Act has been tested very little in case law,¹² England's Act would imply that a user of a word-processor or excel spreadsheet would own exclusive rights in his or her respective essays or worksheet compilations. A user of a word-processor would be solely responsible for the "arrangements necessary for the creation of the work,"¹³ and thus, would ostensibly acquire copyright protection in the resulting output. However, England's Act provides an ambiguous answer in the case of a fractal output created by a computer program. If the user only contributes an assignment of number of iterations to the fractal output, then the user is not responsible for the "arrangements necessary for the creation of the work."¹⁴ If this argument is accepted, then Queen Elizabeth is no better position than the U.S. Copyright Office to answer the mysterious question of who created the fractal output.

¶ 9 In addition, the industrial applications of fractals present a problem because a useful art is not protected subject matter under the Copyright Act. As the court in *Baker v. Seldon* held, the task-oriented dimension of a useful process or idea is not copyrightable expression.¹⁵ Precedent has made clear that the Copyright Act does not protect utilitarian aspects of a work.

¶ 10 To illustrate the dilemma, an analysis of each of the five possible answers to the question of whom to reward will follow. While each of the five theories have convincing arguments, this paper will help reveal the need for a more thorough understanding of computer-generated works as applied to fractals and Mandelbrot Sets.

THE COMPUTER PROGRAMMER

¶ 11 At first blush, a computer programmer can make a strong claim to a copyright in any output of a computer program. The creativity and originality that the programmer contributes to the source code is the impetus that generates the Mandelbrot Set. The programmer contributes substantially to the output and thus should be rewarded for his efforts that lead to the generated work of art. In addition, the output generated from the computer program can be viewed as a derivative work of the underlying copyrighted program; thus guaranteeing protection of any

output to the copyright owner of the program. However, several crucial problems arise in characterizing the output as a derivative work, leading to a conclusion that the fractal generation should not belong to the computer programmer.

¶ 12 The intellectual demand and large amount of effort required to write a computer program are very convincing arguments in favor of granting copyrights to the programmers. The Mandelbrot Sets would have likely never come into existence without the originality and creative spark of the computer programmer. Especially compared to the user of a fractal generator program, who merely types in the word "compose" or "compile" to create an output, the programmer has contributed more thought, devoted more time and expended more energy to create such a work of art. However, there are several reasons why it is simply not feasible to award copyright protection to the computer programmer for direct authorship of the output.

¶ 13 The argument that the programmer should be rewarded for his efforts would have been much more persuasive before 1991. However, after the Supreme Court explicitly rejected the "sweat of the brow" theory in *Feist*, hopeful creators became unable to prove a copyright based upon "hard work."¹⁶

¶ 14 The work made for hire doctrine¹⁷ of the Copyright Act provides an interesting justification for the programmer acquiring copyright protection in the fractal outputs. The implication of the work made for hire rule is that an employer need not have had any direct role in the creative process to gain a copyright in the employee's result.¹⁸ Therefore, the rule could be used as a defense to the argument that the computer programmer is not sufficiently involved with the fractal output. However, the doctrine only applies when an employee, acting within his or her scope of employment or specifically ordered or commissioned, prepares the work.¹⁹ Thus, it is unlikely a court would find that the work made for hire doctrine would apply in situations where the programmer is not in a position of an employer and the user is not considered an employee.

¶ 15 Frequently, the computer-generated fractals that are randomly produced by chaotic systems create beautiful pieces of art.²⁰ Users of these fractal programs can make a convincing argument that computer programmers may not possess the requisite taste for art that is required to produce the selected arrangements. In other words, if the programmer cannot distinguish one piece of art from another, he may not be the one the Copyright Office had in mind when it granted exclusive rights in works of art. Mandelbrot Sets are frequently created by "tinkering" with the number of iterations or transformations performed; thus furthering the view that the

user contributes far more to the output than the programmer. In addition, by developing a copyrightable source code,²¹ the programmer has arguably only created a potential for creation. Just as Bill Gates does not own a copyright in works produced by Microsoft computers, as much as he would like to, a programmer should not own a copyright in outputs created from his or her program.

¶ 16 Opponents of programmer-copyrights also argue that selling, leasing or licensing the program to a user has already rewarded the programmer for his work. A copyright in the output generated from the program doubly rewards the programmer and ostensibly takes from the user a deserved copyright. However, this is a fairly weak policy argument because the primary purpose of the Copyright Act is to provide incentives to create new works, rather than to reward authors.²²

¶ 17 In addition to the direct authorship argument in favor of the programmers, an argument can be made that all Mandelbrot Sets are derivative works owned by the programmer. A determination that the outputs are derivative works of the underlying computer program would give the computer programmer exclusive rights to create the fractal outputs. However, numerous problems are associated with defining the outputs as derivative works; so much so that a derivative works argument made in favor of a programmer will likely fail.

¶ 18 The most convincing argument in favor of defining the output as derivative works is that the Mandelbrot Sets are "based upon" the underlying computer program.²³ The Mandelbrot Sets are spawned from the computer program; without the latter, the former would never come into existence. From the common sense understanding of the phrase "based upon," it appears that the fractal output is derived from, owes its existence to, and has stemmed from the program. However, despite the broad language of the Copyright Act in defining a derivative work, there is no indication in the 1976 Act that Congress intended to expand the exclusive rights guaranteed to copyright holders to prepare derivative works.²⁴ Bolstering the view that computer-generated outputs of fractal geometry are not a derivative work is the fact that the artwork contains no recognizable block of expression from the program.²⁵

¶ 19 Furthermore, if the outputs of the computer program are considered derivative works, a programmer would seemingly own all rights in the derivative works, and the programmer would accordingly obtain an exclusive right to use his copyrighted computer program. This "right to use," however, is not an exclusive right defined in the Copyright Act.²⁶ Until Congress amends the Act to include the right to use a copyrighted work, computer programmers should

not gain the benefit of using a fractal generator and hoarding the outputs.²⁷ Additionally, by selling, leasing or licensing a fractal generator, the programmer is arguably giving an implied license to use the work; why else would the user buy the program?

¶ 20 Additionally, congressional intent appears to support, indeed mandate, the view that the outputs are not derivative works. Congress refrained from making a determination of the copyrightability of computer-generated works in the 1976 Act. Congress created a National Commission on New Technological Uses of Copyrighted Works (CONTU) to look into the matter. The Final Report of CONTU makes the determination that the user of the program is the author of the outputs of computer-generated works.²⁸ Therefore, to suggest that a computer programmer could own the rights to any outputs (negating the claim by the users of the program) would render meaningless CONTU's determination that the user acquires a copyright and ownership in the outputs of a computer generated work.²⁹

THE USER

¶ 21 Perhaps the most appealing candidate for ownership rights in the output is the user of the computer program. If in most situations the user is the person most directly responsible for literally "fixing" the work in tangible form, it is hard to ignore a user's demand for copyright protection. The user is most deserving of ownership of computer-generated work for several reasons. For example, the user may attempt to create a specific Mandelbrot Set, by trial and error, with particular color assignments and distinctive chaotic arrays. However, there are several features of fractal-generations that put into doubt a copyright vesting in the user.

¶ 22 In 1951, the 2nd circuit explained that only a modest grade of originality is required to secure a copyright in a work of art.³⁰ The court in *Alfred Bell* ruled that striking uniqueness, ingenuity, and novelty are not required of a copyright holder.³¹ The Court's de minimis standard for originality supports the user's claim for copyright status of a computer-generated work of art. By "tinkering" with the iteration inputs and transformation selections, a user can make a fairly convincing argument that his or her actions have contributed directly to the originality of the particular Mandelbrot Set.

¶ 23 Several websites allow users to create, interpret and manipulate Mandelbrot Sets.³² These websites allow the user to change the number of iterations, vary the zoom level, and change the assignment of colors to different "rates of escapes."³³ Few could argue that the

user's inputs into the end product are not substantial. Determining the values of certain color assignments involves both originality and uniqueness, and seems to satisfy the low level of creativity required. The user can be described as a painter, choosing from a palette which colors to apply to the canvas. However, as the programs on these websites illustrate, a user could produce a work of art by clicking on the link "Draw the Mandelbrot Set," without altering the pre-selected variables. Neither the current case law nor the Copyright Act persuasively supports copyright status in this type of "unauthored" fractal output.

¶ 24 Similar to computer programmers, users of fractal programs argue that the work made for hire doctrine of §201(b) guarantees copyright protection. An even stronger argument than for programmers, a user who has licensed, purchased or leased a computer program can be said to be "employing" the computer.³⁴ The program users are employing the computer to produce creative works of art. In essence, a user can own the rights to whatever outputs his or her "employee" (the computer) has produced. Even though the Final Report made by CONTU refers to the user "as one who employs the computer,"³⁵ this argument would likely fail because the computer cannot be viewed as a person acting within the scope of employment. Lacking the traditional characteristics of an "employee" (desire to form a union, for example), the courts likely will not be receptive to ownership rights asserted by the user under this rationale.

¶ 25 The Final Report prepared by CONTU in 1978 fully supports the view that the user of the computer program obtains copyright protection in the output.³⁶ However, the subsequent report issued by the Office of Technology in 1986 (the OTA report)³⁷ questions CONTU's assessment that the computer, like a camera or a typewriter, provides the users exclusive copyrights in the resulting pictures or papers.³⁸ The OTA disagrees with CONTU's determination that the computer is an inert tool of creation and raises the possibility for authorship in the computer.³⁹

BOTH THE USER AND THE PROGRAMMER

¶ 26 Under a joint authorship analysis, the programmer may be viewed as planting the initial seed, while the user is watering and eventually harvesting the fractals. While this approach seems the most reasonable from a "Can't we all get along?" viewpoint, substantial precedent, both academic and judicial, refutes the joint authorship argument.

¶ 27 The first roadblock to joint authorship is the requirement that both the user and programmer's contributions must be copyrightable.⁴⁰ Stanford University Professor Paul Goldstein has formulated a "copyrightable subject matter test" to judge whether a work can be

jointly owned. According to Professor Goldstein,

"A collaborative contribution will not produce a joint work, and a contributor will not obtain a co-ownership interest, unless the contribution represents original expression that could stand on its own as the subject matter of copyright."⁴¹ Goldstein's view is substantiated by the use of "author" in §101, which suggests that each collaborator's contribution must be a copyrightable "work of authorship" within the meaning of §102(a).⁴² Several courts have adopted Goldstein's test in reference to joint works of authorship.⁴³ However, an application of Goldstein's test to computer-generated works raises substantial concerns: it is doubtful that both the programmer and the user produce independently copyrightable subject-matter. There are a multitude of reasons that the user and the programmer, individually, should not be guaranteed a copyright in the computer-generated outputs. Asking for joint authorship compounds the difficulty, as proof of independent copyrightable subject matter would be needed. Perhaps the copyrightable fractal program would suffice for the programmer's contribution, but then the issue of whether the two parties collaborated on the result would be raised. In denying joint authorship in a work of art, the Court in *Picture Music, Inc. v. Bourne, Inc.*, held that there was no collaboration whatsoever between the claimed joint authors.⁴⁴ Applying this rationale to the computer-generated Mandelbrot Sets means that the user and programmer are not entitled to joint authorship in the outputs because of their lack of collaboration. Once the programmer has sold, leased or licensed his copyrighted program to a user, his stake in the output is significantly reduced. The benefit that the programmer has received from the sale, lease or license would effectively end the programmer's interest in the outputs. A large inequity would ensue if a programmer could assert joint authorship in every fractal generation made from the sale of three thousand computer programs to the general public. Therefore, while the joint authorship approach would ease the tension between the user and programmer, and provide an equitable result, precedent and statutory authority do not support such a solution.

THE COMPUTER

¶ 28 Eight years after the Final Report issued by CONTU, the Office of Technology issued its own report.⁴⁵ CONTU's conclusion that the user of the programmer is entitled to copyright protection in the outputs of fractal programs has been effectively overruled by the OTA report. The primary difference between the two reports is OTA report's description of the computer as a non-inert tool. Once a computer, which compiles the instructions of a particular

fractal program, can be described as something more than a mere camera or typewriter, the stage is set for granting a copyright to the computer itself.

¶ 29 In comporting with the Copyright Act's requirement of originality, an author must be able to think about, consider and process information so as to create a unique work of art suitable for copyright protection.⁴⁶ A computer's ability to process information can be demonstrated in most any application that is run on a computer; in essence, a computer's primary purpose is to process bits of data. Admittedly, computers are not able to evince "taste" for art. However, this "lack of taste" should not stand in the way of a computer gaining a copyright in a computer-generated work. Courts have ruled that artistic merit is not a hurdle for a creator to pass before he or she can acquire copyright protection in a work.⁴⁷ As Justice Holmes expressed in *Bleistein*,

It would be a dangerous undertaking for persons trained only to the law to constitute themselves final judges of the worth of pictorial illustrations, outside of the narrowest and most obvious limits.⁴⁸

¶ 30 While the thought of a computer thinking independently is a radical idea, several theories exist for such a proposal. Perhaps the most convincing of these arguments is best seen in Artificial Intelligence (AI) computers. As the following excerpt from a computer-generated work illustrates, a computer can independently produce creative works; likely displaying the requisite originality required by the Copyright Act,

Helene watched John and cogitated: A supper with him? Disgusting! A supper would facilitate a dissertation and a dissertation or tale was what John carefully wanted to have. With what in mind? Wine, otters, beans? No! Electrons. John simply was a quantum logician; his endless dreams were captivating and interesting; at all events Matthew, Helene, and Wendy were assisting him in his infuriated tries to broaden himself. Now legions of dreams itched to punch Wendy's consciousness. Yet John whispered, 'Just a minute! Helene's a maid, I'm a quantum logician; can maids know galaxies and even stars or a multitude of galactic systems? Can maids realize electrons?'⁴⁹

¶ 31 Even though computers are capable of exhibiting creative and fanciful works of art,⁵⁰ granting copyright protection in the latest ThinkPad is dangerous and impractical. Computers are simply unable to perform several tasks that a copyright holder must perform to be eligible for protection. For example, a computer cannot have standing to sue an alleged infringer of its work. *ThinkPad 1452 v. Compaq 1342* is simply not a reality. In addition, a computer is

not capable of transferring rights to others (e.g. renewal rights, licensing arrangements) to satisfy the needs of a changing market. In other words, computers are not able to evolve with a shifting market; therefore, computer-owned copyrights debilitate and hamper a market that hinges on and benefits from alienability of rights and interests.

¶ 32 However, a quasi-market failure and enforceability concerns from computer-owned copyrights are not convincing obstacles in disallowing a computer from owning a copyright. Copyright law is viewed with more certainty and followed with more precision if we had arguments other than, "We can't grant copyrights to computers because it just doesn't seem right" and, "It wouldn't work in practice." Luckily there are persuasive reasons why computers cannot own copyrights. For example, even though a computer is capable of producing creative works, the real impetus behind such works is the computer programmer who "told" the computer how to treat certain pieces of data. In 1983, in the hearings before the Subcommittee on Patents, Copyrights and Trademarks of the Senate Committee on the Judiciary, Harvard Law School Professor Arthur R. Miller remarked, "Behind every robot there is a good person."⁵¹

¶ 33 In addition, the main purpose of granting copyright protection is to stimulate creation and promote original works of authorship. Computers cannot be "encouraged" to perform functions by offering exclusive rights in the outputs. Furthermore, as the *Trade-Mark Cases* explain, a work of art should not be protected if it fails to "depend upon ... any work of the brain; it requires no fancy or imagination, no genius, no laborious thought."⁵² Therefore, even though computers compile the information and process the data, human authors are responsible for the circuitry of the hardware, ingenuity of the programs and, arguably, the imagination of the fractal outputs. Even though the Copyright Act does not prohibit computers from owning copyrights,⁵³ computers do not possess the qualities required of authors to qualify for copyright protection.

NO ONE SHOULD ACQUIRE A COPYRIGHT

¶ 34 The last possibility for copyright protection is that no one should be able to own a copyright in a fractal generation. This option may be the best, as none of the others are suitable responses to the problem.

¶ 35 One particularly complicated matter arises when the user has not created the output voluntarily or with any specific intent. This question was discussed in *Alfred Bell & Co. v. Catalda Fine Arts, Inc.* The court in *Alfred Bell* held that unintentionally slipping up on a painting does not preclude copyright protection.⁵⁴ This supports the view that a user need not

intentionally create a Mandelbrot Set to acquire copyright protection. However, the court's ruling in *Alfred Bell* may only apply to the specific facts of the case. In *Alfred*, the painter intentionally attempted to copy specific mezzotint engravings, but understandably miscued and did not create a "perfect" copy. The "intentional" element in *Alfred Bell* is sufficiently different from the "intentional" element in the computer-generated work context. It is this difference in the meaning of "intentional" that may prevent an application of *Alfred Bell's* ruling in the computer environment. Not knowing what will happen when one hits "compile" or "draw the Mandelbrot Set" harms the user's argument for copyright protection more so than accidentally slipping while copying a specific mezzotint engraving.

¶ 36 Copyright protection is never allowed for an idea or mathematical formula. Einstein was not allowed to patent or copyright the formula, $E = mc^2$, because the mathematical concept is useful and, moreover, ideas are not protected by copyright laws. As described earlier, fractal theory is a useful concept that has many industrial applications:

A fractal is a colored image that mathematically models how well things survive in their environments. Life forms survive through a process of constant change, change that must take place within reasonable bounds if the organism is not to be destroyed. Science uses fractals to model and predict the survival of everything from hurricanes to intergalactic nebulae. In fact anything whose survival is dependent upon its surroundings can be modeled with this new math.⁵⁵

¶ 37 Defining and explaining fractals is a complicated matter; however, at its foundation, fractals represent nature and generally characterize chaotic systems. As such, acquiring copyright protection in these representations of nature seems counterintuitive. Copyright protection should not be allowed in situations where there are private exploitations of engineering principles or in instances where mathematical concepts are privately owned.

¶ 38 However, fractal theory may represent a middle ground, somewhere between $E = mc^2$ and *Gone with the Wind*. That is, fractals are more deserving of protection than a formula or concept, but less deserving than a story about the Civil War. Some insight into the matter can be found in *Burrow-Giles Lithographic Co. v. Sarony*.⁵⁶ In *Burrow-Giles*, the lithographic company argued that a photograph is merely a mechanical reproduction of a natural phenomenon, and thus could not "embody the intellectual conception of its author, in which there is novelty, invention, [and] originality"⁵⁷ as is required in the Copyright clause.⁵⁸ While that argument is strong, the Court ruled that the photographer exhibited sufficient originality to

gain copyright protection. Therefore, the case implies that a Mandelbrot Set can be protected even though it is a slice of nature and represents a natural phenomenon.

¶ 39 In addition, it is questionable whether a Mandelbrot Set represent an expression of an idea or an idea itself. A sine wave cannot be protected by copyright because it represents a mathematical concept; therefore, if a Mandelbrot Set can be compared to a sine wave, then it is likely that courts will interpret fractal generations as unprotected ideas. Conversely, if one looks to the expressive aspects of the Mandelbrot Set, focusing on the unique array of colors and the original and unique chaotic patterns, then a strong case can be made that the computer outputs should be protected by someone (or something).

¶ 40 Moreover, if fractal generations can only be expressed in one way, then the merger doctrine would apply and the work would not be protected under copyright law.⁵⁹ Generally, when encountering a functional work, which fractals arguably are, the courts will limit protection to avoid conferring *de facto* monopoly over the utilitarian aspects of the work.⁶⁰ The courts have yet to make a distinction between idea and expression for computer-generated Mandelbrot Set outputs. Because the distinction is very hard to conceptualize, the courts are ill-prepared to deal with the merger doctrine in this context. The situation is not unsolvable, however, because chaotic systems can always be expressed in an infinite number of ways. Therefore, because a Mandelbrot Set has a number of different ways of expressing the idea, the merger doctrine is not likely to prevent copyright protection.

¶ 41 In 1973, the Supreme Court in *Goldstein v. California* interpreted the original work of authorship requirement to include "any physical rendering of the fruits of creative intellectual or aesthetic labor."⁶¹ This requirement raises some problems for the computer-generated Mandelbrot Sets because, if one assumes that the output is a depiction of a mathematical concept or theory, then the "creative intellectual or aesthetic labor" is not present. There is little or no creativity or aesthetic labor involved in the statistical, arithmetical or numerical computations found in Mandelbrot Sets.

¶ 42 That said, to comport with the purpose of promoting science and art, someone should own the rights in the fractals, if for no other reason than to bring these fractal outputs to the public. An argument can be made that the market provides the encouragement that the programmers need to write these programs and that the users need to generate the outputs. The theory is that the programmer will write these programs with the anticipation of selling, leasing or licensing, and the user will purchase the programs with the expectation of creating and selling

fractal outputs. However, we cannot rely on the market to bring these fractal outputs to the fore; a grant of exclusive rights in these computer-generated works of art needs to exist to provide harmony between protectionism and motivation to produce.

CONCLUSION

¶ 43 One possibility of protection is related to the holding in *Baker v. Seldon*. Perhaps the programmer should be entitled to copyright protection if he actually compiles the program and creates the work, and the user should be entitled to copyright protection if he is the one who actually compiles the work. This is similar to the concept in *Baker*, where the author of the accounting book would be entitled to a copyright if he made use of the accounting principles, but a user would be entitled to copyright protection if he made use of the same accounting principles. This result, while equitable, ignores the question of whether the computer-generated fractals should be protected at all.

¶ 44 Another possibility, which takes into account the questionable copyrightability of fractals, is a thin scope of protection. The court in *Feist* discussed the option of thin protection for compilations and collections of facts. This rationale can be applied to Mandelbrot Sets; however, the exact degree of protection is somewhat uncertain. For example, when the scope of protection is limited for compilations to the copyrightable components of the expression, courts are then required to perform a fact-specific analysis with no general rules. The same problem will exist for Mandelbrot Sets because defining the copyrightable expression in a fractal generation is uncertain and the Copyright Act provides very little guidance. Distinguishing one database from another to define the copyrightable expression for infringement purposes is much easier than is distinguishing artistic fractal generations from one another.

Even though the copyright system has proven malleable enough to absorb each new medium of expression (for example, the Internet and satellite broadcasts), apprehensions about the regime's boundaries surface whenever a new information format emerges.⁶² The emergence of computer-generated fractals is not an insurmountable obstacle for the Copyright Act. The Act has had an "extraordinarily successful history of assimilating new technologies" and there is no reason why the Act will be unable to incorporate Mandelbrot Sets.⁶³

¶ 45 Times have changed since Arthur Miller remarked,

It is premature to consider the status of a work of expression that is truly the product of a computer's 'mind.' Indeed, it is questionable whether that type of creation will materialize

within any time frame worth considering. Today's 'computer-generated' works still have identifiable human authors, and that will be true for the foreseeable future. Therefore, the human element in the creation of these works is sufficient to sustain their copyrightability and resolve any question of authorship ... obviously there [is] no need to confront the [question of who shall we reward], because a human author always would be using the computer and program to do his bidding.⁶⁴

¶ 46 The issues are now much more complicated for computer-generated fractals than Arthur Miller recently stated. With the emergence of Mandelbrot Sets, the question has now been presented to the U.S. Copyright Office: who is doing the bidding?

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Footnotes

1. See, e.g., Digital Millennium Copyright Act (DMCA).

2. See, e.g., §§112, 114.

3. See, e.g., §117.

4. For example, §§ 1201-1205 deal with the protection of a digital fence, and the United States District Court - SDNY has dealt with the protection of DVD encryption in *Universal City Studios, Inc. v. Reimerdes*.

5. For example, while the Internet raises several issues that have not yet been answered, several cases have examined these complex issues, such as *Religious Tech. Ctr. v. Netcom On-Line Comm. Servs., Inc.*, and *RealNetworks v. Streambox*.

6. See <http://www.mboss.f9.co.uk/ffusion/open.html>.

7. For the materials on Fractals, please refer to Fisher, Yuval, *Fractal Image Compression: Theory and Application*, Springer-Verlag, New York, 1995, and Hartmut Jurgens et al, *Chaos and Fractals: New Frontiers of Science*, Springer-Verlag, New York, 1992.

8. See <http://forum.swarthmore.edu/~sarah/mandelbrot.all.html>.

9. For example, the coastline of Great Britain was recently measured by using fractal image compression and measurement.

10. See <http://users.med.auth.gr/~karanik/english/icmabs/p68.html>("Strong manipulations with needle in a shu point in some acute disturbance are explained with the decreasing of the action on the basis of the second law of Fractal theory").

11. Copyright, Designs and Patents Act, 1988, ch. 48, §§ 9(3), 178 (United Kingdom).

12. See <http://www.jisc.ac.uk/pub/copyright/charles2.html>.

13. *supra* note 11.

14. *Id.*

15. 101 U.S. 99 (1879). The argument that the programmer should be rewarded for his efforts would have been much more persuasive before 1991. However, after the Supreme Court explicitly rejected the "sweat of the brow" theory in *Feist*, hopeful creators became unable to prove a copyright based upon "hard work."

16. See *Feist v. Rural Telephone Service Co.*

17. See §201(b). The work made for hire rule gives a direct copyright interest to employers for all works prepared by their employees.

18. *Id.*

19. See §101 (definition of "work made for hire").

20. See <http://forum.swarthmore.edu/~sarah/mandelbrot.all.html>.

21. See, e.g., *Computer Associates International, Inc. v. Altai, Inc.*

22. See Article I, Section 8, Clause 8 (Copyright Clause): "to promote the Progress of Science and the useful Arts..."

23. See §101 (definition of "derivative work").

24. See Pamela Samuelson, *Allocating Ownership Rights in Computer-Generated Works*, 47 U. Pitt. L. Rev. 1197 at 1213 (1986).

25. See *M. Nimmer, Nimmer on Copyright* §3.06 at 3-22.3 (1985), and *Berkic v. Crichton*, 761 F.2d 1289 (9th Cir. 1985); and *Litchfield v. Spielberg*, 736 F.2d 1352 (9th Cir. 1984);(To constitute a violation of §106(2), the infringing work must incorporate a portion of the copyrighted work in some form).

26. §106 (definition of exclusive rights granted to copyright owner).

27. See *supra* note 24 at 1219.

28. Final Report of the National Commission on New Technological Uses of Copyrighted Works, July 31, 1978, Library of Congress/Washington 1979, page 44.

29. See *supra* note 24 at 1211.

30. See *Alfred Bell & Co. Ltd. V. Catalda Fine Arts, Inc.*, 191 F.2d 99 (2d. Cir. 1951).

31. See *id.*

32. See, e.g., <http://forum.swarthmore.edu/alejandre/applet.Mandelbrot.html> and, <http://www.mathstat.usouthal.edu/~lynn/modeling/Mandelbrot.html>.

33. See *id.*

34. See *supra* note 24 at 1203.

35. *Supra* note 28 at 45.

36. See *supra* note 28.

37. See Office of Technology's Assessment of Intellectual Property Rights in the Age of Electronics and Information (1986) (OTA Report).

38. *Id.* at page 72-73.

39. *Id.*

40. *Donna v. Dodd, Mead & Co., Inc.*, 374 F. Supp. 429 (S.D.N.Y 1974) and *Erickson v. Trinity Theatre*, 13 F.3d 1061 (7th Cir. 1994).

41. Paul Goldstein, *Copyright: Principles, Law, and Practice* §4.2.1.2, at 379 (1989).

42. §101's definition of "joint work": a work prepared by two or more authors.

43. See *Ashton-Tate Corp. v. Ross*, 916 F.2d 516, 521 (9th Cir. 1990), and *Whelan Assocs., Inc. v. Jaslow Dental Lab., Inc.*, 609 F. Supp. 1307, 1318-19 (E.D. PA. 1985).

44. 314 F. Supp. 640 at 647 (S.D.N.Y 1970).

45. See *supra* note 37.

46. See *supra* note 24.

47. See *Bleistein v. Donaldson Lithographing Co.*

48. *Id.*

49. Racter, *Soft Ions, OMNI*, Apr. 1981, at 96-97.

50. See Peter Garrison, *Glued to the Set*, Harv. Mag., Jan.-Feb. 1989, at 27, 28-29, and Ken Sofer, *Art? Or Not Art?*, *Datamation*, Oct. 1981, at 118, 122-23.

51. Arthur R. Miller, *Copyright Protection for Computer Programs, Databases, and Computer-Generated Works: Is Anything New Since CONUT?*, 106 Harv. L. Rev. 977 at 1045 (1993).

52. 100 U.S. at 94.

53. See §102.

54. See *supra* note 30.

55. <http://www.lightlink.com/homer/what.html>.

56. 111 U.S. 53 (1884).

[57.](#) *Id* at 58-59.

[58.](#) *See supra* note 51 at 1061.

[59.](#) *See supra* note 15.

[60.](#) *See* Marshall Leaffer, *Understanding Copyright Law*, 3rd Edition, Matthew Bender, 1999, at page 80.

[61.](#) 412 U.S. 546, 561

[62.](#) *See supra* note 51 at 1053-54.

[63.](#) *Id.*

[64.](#) *Id.*