



The Efficient Boundary of Inventorship and Authorship

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Recommended Citation

Steven S. Kan, *The Efficient Boundary of Inventorship and Authorship*, 19 DePaul J. Art, Tech. & Intell. Prop. L. 235 (2009)

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THE EFFICIENT BOUNDARY OF INVENTORSHIP AND AUTHORSHIP

By Steven S. Kan¹

ABSTRACT

Knowledge works have their creators. As structural changes in economic development have made collaboration indispensable for a knowledge project, courts are increasingly involved with inventorship and authorship disputes because neither is statutorily defined. Through a workflow model of knowledge creation, this Note elucidates virtual transactions, market substitutable endeavors, and their associated transaction costs to pin down intellectual contribution as the efficient boundary of inventorship and authorship. A review of frequently cited cases shows that American judges have insisted on intellectual contribution in determining true inventorship and authorship and helped to develop the United States into the world's knowledge center in the twentieth century.

1. Visiting Professor, Graduate Institute of Law and Economics, College of Economics, Zhejiang University. I am grateful to Dean Jin-Chuan Shi for relieving some of my teaching duty, to Professors Tze-Shiou Chien and Chun-Sin Hwang for helpful comments and suggestions, and to former thesis student Lydia Liu for inspiring me into this interesting research. For previous drafts leading to this Note, I appreciate the encouragement and feedback of law and economics seminar participants at Nanjing University of Science and Technology, Zhejiang University, and National Tsing Hua University, and conference participants at Taiwan's First Conference on Empirical Law Research and the Sixth Chinese Law and Economics Forum. Any merit of this Note is God's grace; all errors are mine.

THE EFFICIENT BOUNDARY OF INVENTORSHIP AND AUTHORSHIP

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I. INTRODUCTION

To whom a patented invention or a copyrighted work owes its intellectual contribution should be as important as who owns the intellectual property. The reason is that an intellectual property simply cannot come into existence without someone having made the intellectual contribution. Additionally, patent and copyright infringement lawsuits have often turned into disputes over the true inventor and author involved. The promotion of science and the useful arts, therefore, comprises two parts—the protection of intellectual property as an object of commercial exchange and the protection of the subject making intellectual contribution.² Insofar as an inventor has the patent application right and an author has the initial ownership of copyright, the laws even suggest that intellectual property protection has actually stemmed from the intended constitutional protection of subjects making intellectual contributions.³ Nevertheless, moral rights that protect non-pecuniary interests of authors in civil law countries are just beginning to catch the attention of American legal scholarship.⁴

2. U.S. CONST., art. I, § 8, cl. 8 (“To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.” (emphasis added)).

3. See 17 U.S.C. § 201(a) (2006) (initial ownership of copyright); 35 U.S.C. § 111(a)(1) (2006) (patent application right).

4. See Roberta Rosenthal Kwall, Copyright and the Moral Right: Is an American Marriage Possible?, 38 VAND. L. REV. 1 (1985), for an introduction

Similarly, in sharp contrast with voluminous law and economics literature on intellectual property protection,⁵ there is little attention to the protection of subjects making intellectual contribution from an economic perspective.⁶

In the United States, only the author of a work of visual art has the statutory right of attribution.⁷ Attribution of true inventors and authors is thus primarily protected through court standards developed from case decisions. Determination of inventors and authors, however, presents a problem in court because inventorship and authorship are not statutorily defined. As a result, litigants proclaim their inventorship or authorship through attribution in a patent application or a copyright registration, or allege that they have made some contribution to the invention or authorial work at dispute.

The United States has nonetheless become the world's top knowledge center in the 20th century. Since problematic determination of disputed inventorship and authorship may adversely affect the accumulation of scientific and artistic knowledge stocks, this Note inquires into how American judges

of moral rights and an analysis of their compatibility to the United States legal system. But see Cyrill P. Rigamonti, Article, Deconstructing Moral Rights, 47 HARV. INT'L L.J. 353 (2006), for alternatives in the United States legal system that would tackle some of the concerns raised by scholars advocating moral rights. Ms. Rigamonti argued that statutory enactment of moral rights in the United States has likely reduced authorial protection.

5. For example, the protection of intellectual property is featured prominently in WILLIAM M. LANDES & RICHARD A. POSNER, THE ECONOMIC STRUCTURE OF INTELLECTUAL PROPERTY LAW (2003) and STEVEN SHAVELL, FOUNDATION OF ECONOMIC ANALYSIS OF LAW (2004). While the latter is silent on attribution protection, the former only considers it to fall in the realm of other laws against fraud.

6. For an exception, see Catherine L. Fisk, Credit Where It's Due: The Law and Norms of Attribution, 95 GEO. L.J. 49 (2006) (detailing attribution's role in signaling human capital in knowledge economy). Additionally, a related bargaining model of name orderings that neglects the distinction between true and false authors is in Maxim Engers et al., First-Author Conditions, 107 J. POL. ECON. 859 (1999).

7. See 17 U.S.C. § 106A (2006). Enacted in the Visual Artists Rights Act of 1990, the attribution right enables the author to claim authorship of her work and to exclude others from using her name for a work she did not create. The author can enjoy the right throughout her life; additionally, she may waive it in writing, but not transfer it. See *id.*

have contributed to the great American achievement through relevant court standards.⁸ Filling the gap of law and economics literature, I use a workflow model of knowledge creation to obtain a set of economic logic establishing intellectual contribution as the efficient boundary of inventorship and authorship. In this framework, frequently cited court cases since late 19th century are carefully reviewed. Consistent with the set of economic logic, my case review shows that courts have scrutinized litigants' actual endeavors in the knowledge project at dispute and established intellectual contribution as the boundary of invention conception, copyright originality, sole inventorship, and sole authorship. By insisting on intellectual contribution and protecting true knowledge creators, American judges have served the Copyright Clause well and helped to develop the United States into the world's top knowledge center.

The economic logic and the outstanding contribution of judges to knowledge accumulation can be intuitively appreciated. Since knowledge projects of scientific or artistic nature share some common workflow steps, a workflow model is adopted to include the following six common steps: (1) initiating a project idea; (2) gathering data; (3) conducting experiments; (4) confirming the project idea; (5) instantiating the confirmed project idea; and (6) fixing consistent instantiations in a tangible medium.⁹ Before the 19th century, all the six workflow steps were taken by the same person to become an inventor or author. As specialization and the division of labor deepened with technological progress and market expansion, it became unnecessary for a knowledge creator to perform all the steps. Economic development over time also changed the configuration of transaction costs, and the changes

8. For increasing concerns about misattribution of knowledge works, see Kyle Grimshaw, *A Victory for the Student Researcher: Chou v. University Of Chicago*, *DUKE L. & TECH. REV.* 35 (2001), Lisa G. Lerman, *Misattribution in Legal Scholarship: Plagiarism, Ghostwriting, and Authorship*, 42 *S. TEX. L. REV.* 467 (2001), and Sean B. Seymore, *My Patent, Your Patent, or Our Patent? Inventorship Disputes Within Academic Research Groups*, 16 *ALB. L.J. SCI. & TECH.* 125 (2006).

9. The workflow model is process-centered instead of "work-centered"; for the latter approach and criticisms against it, see Ryan Littrell, *Note, Toward a Stricter Originality Standard for Copyright Law*, 43 *B.C. L. REV.* 193 (2001).

have been manifesting in various ways.¹⁰ As a result, useful data can now be acquired by paying fees to database operators and experiments can be conducted by students. The structural changes have caused scientific and artistic knowledge projects to involve a number of participants. Attribution disputes rose, in part, because participants who performed some steps started to claim attribution in courts.

The make-or-buy decision associated with a knowledge project is, in the Coasian perspective, dependent on the comparison between internal and market transaction costs.¹¹ The promotion of science and useful arts can certainly be better met by allowing knowledge creators to utilize services available in the market because of the low transaction cost involved. A market substitutable endeavor, however, represents application of existing knowledge but not creation of new scientific or artistic knowledge. On the other hand, inventors and authors must engage in costly virtual transactions with targeted patrons in their minds, for example, patent examiners and journal referees. The costs are particularly high and risky because they cannot interact with their targeted patrons as in a Coasian real exchange. Thus, intellectual contribution resulting from costly virtual transaction is the efficient boundary of inventorship and authorship.¹²

10. Structural changes related to inventive activities were carefully researched by Naomi R. Lamoreaux & Kenneth L. Sokoloff, *Market Trade in Patents and the Rise of a Class of Specialized Inventors in the 19th-Century United States*, 91 *AM. ECON. ASS'N ARTICLES & PROC* 39 (2001) (arguing that growing division of labor between specialized inventors and businesses commercializing their inventions was the result of a market in patents); Kenneth L. Sokoloff & B. Zorina Khan, *The Democratization of Invention During Early Industrialization: Evidence from the United States, 1790-1846*, 50 *J. ECON. HIST.* 363 (1990) (arguing that early inventors were dispersed over the population and their skills were not specialized).

11. See generally R.H. Coase, *The Nature of the Firm*, in *THE FIRM, THE MARKET, AND THE LAW* 33 (1988) (analyzing the firm as a nexus of contracts). See Michael Jensen & William Meckling, *Theory of the Firm: Management Behavior, Agency Costs and Ownership Structure*, 3 *J. FIN. ECON.* 305 (1976) for the origin of the term “nexus of contract.” See also Steven N.S. Cheung, *The Contractual Nature of the Firm*, 26 *J.L. & Econ.* 1 (1983) (expounding further on the “nexus of contract” theme).

12. Inasmuch as the boundary of firm is indeterminate in Coase's seminal article, *The Nature of the Firm*, additional specificity is needed to determine the

In the remaining discussion, Section I introduces the workflow model, explains attribution's organizational roles, and obtains the first element of the economic logic—it is inefficient to grant attribution to every participant of a knowledge project. Section II elucidates virtual transaction, market substitutable endeavor, and the transaction costs involved. Two additional elements of the economic logic are obtained along the way; namely, it is inefficient to attribute whoever made nothing but market substitutable endeavors and whoever only paid others for a consistent project she did not envision. Abstracting from the complication of opportunistic behaviors lurking in intellectual collaboration, this Section establishes intellectual contribution as the efficient boundary of inventorship and authorship.¹³ Section III reviews cases regarding invention conception, copyright originality, sole inventorship, and sole authorship to show how courts reached their decisions as if they had a firm grasp of the workflow model and the set of economic logic. A brief conclusion then follows.

II. THE WORKFLOW MODEL OF ATTRIBUTION DETERMINATION

The workflow model is the most salient tool adopted in this Note to penetrate into the problem at hand. This Section starts by describing the workflow model's six common workflow steps and its three assumptions. As workflow steps represent how a project is organized to create new knowledge, attribution has its organizational role in the creation of knowledge works, scientific or artistic. It also has an organizational role in the distribution and use of knowledge works. These organizational roles are introduced with an emphasis on how attribution helps reduce transaction costs in the society.¹⁴ Lastly, I analyze the optimal

boundary of inventorship and authorship. In this sense the workflow model provides the specificity for the efficiency result.

13. Note that my argument of the efficient boundary is abstracted from the complication of opportunistic behaviors between intellectual collaborators. Cases regarding joint inventorship and authorship are thus not reviewed here.

14. See Justin Hughes, *The Personality Interest of Artists and Inventors in Intellectual Property*, 16 *CARDOZO ARTS & ENT. L.J.* 81, 114 (1998) (criticizing

number of attributions of a knowledge work.

A. *The Six Common Workflow Steps*

Workflow is a general concept about the sequence of work steps and usually drawn as a flowchart.¹⁵ A flowchart consists of a number of blocks, in various shapes suggesting the different natures of the steps, and a number of arrows linking the blocks to indicate the structural relationship. There are flowcharts indicating specific sequential steps to be followed by line workers in a factory. The flowchart for customer return of merchandise is usually posted at the customer service center. Software programmers and engineers probably cannot finish a day without reading or drawing a flowchart. While their work steps can be similarly arranged in a flowchart, writers, painters, and legal scholars usually finish a year's work without drawing one.

The flowchart of Figure 1 shows the six common steps of the workflow model. From the top to the bottom, they are the steps of initiating a project idea, gathering data, conducting experiments, confirming the project idea, instantiating the confirmed project idea, and fixing consistent instantiations in a tangible medium. The workflow steps seem, at first glance, to fit better with scientific and engineering endeavors leading to inventions. They also fit literary and other artistic endeavors leading to works of copyrightable subject matter. The following prose-writing simulation offers an example.¹⁶

court holdings to have sacrificed "true" consumer sovereignty). The criticism erred in pitting knowledge creators against consumers; contrarily, economic tradeoffs measured in transaction costs that are borne by both knowledge creators and consumers are the focus of my organizational perspective of attribution.

15. See, e.g., WIL VAN DER AALST & KEES VAN HEE, *WORKFLOW MANAGEMENT: MODELS, METHODS, AND SYSTEMS* (2004).

16. The simulation is adapted from Zhu Zi Qing's *Back Shadow*, an early 20th century Chinese prose that is still being adopted by primary schools across the two sides of the Taiwan Strait.

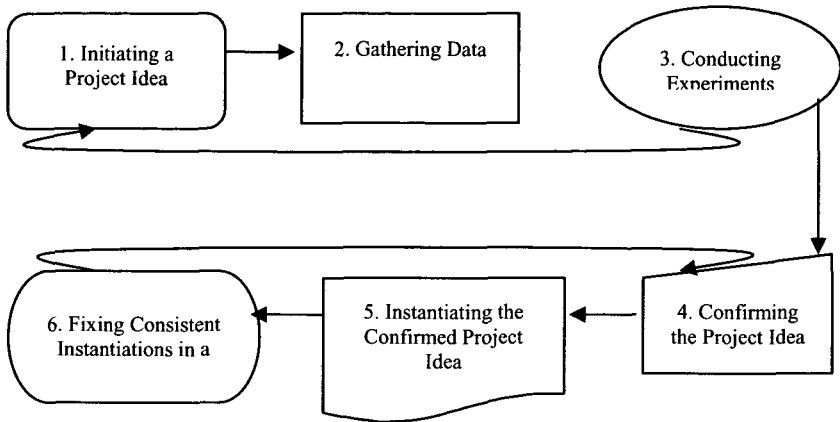


Figure 1: The Workflow Model of Knowledge Project

After being touched by an emotional parting scene at the train station of her home town, a writer came to the idea of a father’s love for his son. There could be many options in setting up her story. She searched, perhaps through recollection, parting themes written by others. She tried experimenting with a quiet, chilly morning scene to usher in on readers’ mind that something was about to happen. As she wrote further, it became clear that she did not really want to build on that scene because the story would be too cold and sorrowful. She realized that she needed something material to show how a father expressed his love. With some more soul searching and experiments, she returned with the confirmed project idea that the son’s feeling for his father’s love was what she really wanted. She did more experiments with her pen to find that she’d better use a sack of oranges carried by the father to instantiate his love for his son.

Eventually, she finished her piece and successfully got it published in a magazine. Readers experienced, from the eyes of the son, that the father, wearing the traditional Chinese long robe, hurried to the crowded and noisy train station with a sack of oranges in his hands, crossed the tracks and accidentally stumbled, picked up one by one the oranges spread around the tracks, placed them backed to the sack, and climbed up again with a smile to send off his son. They found their eyes moist when the son was trying to freeze the blurry back shadow of his father while the

locomotive started cranking and accelerated its momentum.

As suggested, the prose writer went through all the six workflow steps. The upper return curve of Figure 1 indicates further that she experienced an iterative process before confirming the project idea. Similarly, another iterative process, indicated by the lower return curve in Figure 1, took place before the consistent instantiations of her confirmed project idea were fixed in a tangible medium.¹⁷

It takes no more imagination to see that composers, painters, and architects must go through these steps to complete their knowledge projects. Performing artists need to test different moods before they can instantiate confirmed emotional effects in facial looks, hand gestures, or musical instruments. Unlike writers and painters whose work in progress is usually fixed in a tangible medium, performing artists need to take a separate fixing step.¹⁸ The case for photographers, however, needs an expanded view to appreciate that similar steps are indeed there. It is so because photographs of live events are usually taken in a split second and photographers have neither time for experiments nor the iterative process as writers or painters do. In the expanded view of a series of photographs taken over a live event, it can be seen that the photographer is experimenting through the many shots, and her selection of the picture afterwards involves an iterative process.¹⁹ The difference between scientific and artistic endeavors of knowledge creation, therefore, is not with the steps but with the data, instruments, and materials used to instantiate and fix their knowledge work. For instance, instantiation in the context of a

17. Crossing of the two return curves, though common, is not discussed for simplicity.

18. See Bethany M. Forcucci, Note, *Dancing Around the Issues of Choreography & Copyright: Protecting Choreographers After Martha Graham School and Dance Foundation, Inc. v. Martha Graham Center of Contemporary Dance, Inc.*, 24 QUINNIAC L. REV. 931 (2006) (discussing additional endeavors to fulfill the fixing requirement in choreography).

19. See generally Alan L. Durham, *The Random Muse: Authorship and Indeterminacy*, 44 WM. & MARY L. REV. 569 (2002) (discussing the experiment-selection processes in fine arts and music); Christine Haight Farley, *The Lingering Effects of Copyright's Response to the Invention of Photography*, 65 U. PITT. L. REV. 385 (2004) (arguing that the authorship doctrine effectively perpetuates the authorless photography).

patentable invention, usually referred to as embodiment by patent specialists, may involve a particular material applied under a specified range of temperature and in a definite sequence to make it work best.

Three assumptions are behind the chosen workflow steps. The flowchart in Figure 1 does not include the step of obtaining the necessary funds for the project. Funding, however, is very important; no project can be completed without it. Its omission indicates an assumption of funding irrelevance. Funding is a major factor in determining ownership. Therefore, there is an assumption of ownership irrelevance, removing it from the attribution paradigm.²⁰ The justification for the assumption is that attribution of an inventor's or author's name has its own independent value separate from the, admittedly related, ownership interest.²¹ Particularly, recent research in legal history has suggested that a gradual separation of ownership and attribution has indeed started no later than the latter half of the nineteenth century.²²

My second assumption, the fixing assumption, relates to the last

20. *See generally* Diane Leenheer Zimmerman, Authorship Without Ownership: Reconsidering Incentives in a Digital Age, 52 DEPAUL L. REV. 1121 (2003) (providing alternative marketing model of works without copyright enforcement). Total dominance of ownership is implicit in Sara K. Stadler, Forging a Truly Utilitarian Copyright, 91 IOWA L. REV. 609 (2006) (arguing that exclusive copyrights should be restricted under a full-fledged utilitarian system).

21. *See* 17 U.S.C. § 201(b) (2006) (work for hire); 35 U.S.C. § 261 (2006) (assignment of patent application). Under the work-for-hire system, journalists, for example, are attributed at the bylines of a newspaper. Via pre-invention assignment, an inventor retains attribution while future patent ownership would be transferred to her employer. As for a work of visual art, attribution and ownership are clearly recognized as two separate rights. *See also* Beech Aircraft Corp. v. EDO Corp., 990 F.2d 1237, 1248 (Fed. Cir. 1993) (opining that inventorship and patent ownership are separate issues).

22. Catherine L. Fisk, Authors at Work: The Origins of the Work-for-Hire Doctrine, 15 YALE J.L. & HUMAN. 1 (2003) (showing that courts recognized employers' ownership interests before the enactment of the work-for-hire doctrine); Catherine L. Fisk, Removing the 'Fuel of Interest' from the 'Fire of Genius': Law and the Employee-Inventor, 1830-1930, 65 U. CHI. L. REV. 1127 (1998) (demonstrating that the rise of corporations and employment contracts have influenced court decisions).

step where knowledge works considered are fixed in a tangible medium. As copyright protects only works fixed in a tangible medium and patent specification is also contained in a tangible medium, the fixing assumption limits my scope within copyrightable works and patentable inventions.²³

The upper return curve in Figure 1 indicates that the first idea initiated may be revised or abandoned. It also shows that some data collected and experiments conducted may not be directly related to the confirmed project idea of step four. As the arrow between steps five and six shows, the fixed tangible medium contains consistent instantiations, which are in turn derived from the confirmed project idea, as shown by the arrow between steps four and five. Therefore, the third assumption, consistent project assumption, is that steps four, five, and six are consistent with one another. With the consistent project assumption, the knowledge work whose attribution is to be determined in court is defined by the content of the fixed tangible medium as a result of consistent steps four and five. Intellectual contributions in steps one through three are thus defined only with respect to the consistent project steps from four through six. Therefore, the assumption helps avoid repetitive discussions over abandoned ideas, unrelated data, or failed experiments.

B. Organizational Roles of Attribution

Knowledge creators do not live in isolated islands. Their literary, artistic, or inventive works have exchange value; otherwise, there would be no reason to promote and protect the commercial exchange of intellectual property. If their unfinished works or diaries have any meaningful value beyond their life, the value must stem from the social economy where they have been a

23. 35 U.S.C. § 112 (2006) (“The specification shall contain a written description of the invention.”) In this sense, the workflow model complements the intriguing argument for promoting the protection of ideas by Arthur R. Miller, *Common Law Protection for Products of the Mind: An “Idea” Whose Time Has Come*, 119 *HARV. L. REV.* 703 (2006). However, it is not my intention to argue that the same economic logic derived here can be exactly applied to his non-fixed ideas.

member.²⁴ An unfinished painting Mary's mother gave her has no use value because Mary has been keeping it in the basement for years. It neither has any intrinsic value because Mary has not been keeping it for its sake. It has value to Mary because it was from her mother. By additionally considering Mary's mother as a famous painter, we may find the unfinished painting to have been, instead, exhibited in Mary's living room all along, especially if her mother had signed it. It helps show that attribution enhances personhood, use, and exchange values. The personhood theory also helps a better appreciation of the inalienability of attribution.²⁵

Organizational roles of attribution in a social economy can best be understood through both the use and the creation of knowledge works. Users of various tastes and interests are dispersed in the economy.²⁶ Without an efficacious network of distribution channels, users will not be able to know what, where, and when a knowledge work is available. Without a social convention in communicating a knowledge work, an efficacious network of distribution channel is also impossible.

In legal scholarship, for example, the citation of a law review article includes the author name, the title, the journal, the issue and the beginning page, and the year published, whereas the citation of a book does not include the book publisher.²⁷ It is quite clear that communication between legal scholars will be ineffective without such a convention. It goes without saying that there are different conventions in relating to a movie by ordinary movie goers and a patent by specialists in the field. More importantly, personhood

24. William M. Landes, *Copyright Protection of Letters, Diaries, and Other Unpublished Works: An Economic Approach*, 21 J. LEGAL STUD. 79 (1992) (suggesting that the protection of unpublished works is related more to privacy and the First Amendment than copyright interest per se).

25. See Margaret Jane Radin, *Property and Personhood*, 34 STAN. L. REV. 957 (1982) for the personhood theory of value. See Margaret Jane Radin, *Market-Inalienability*, 100 HARV. L. REV. 1849 (1987) for inalienability. Mass production, however, has diluted the and created confusion as to the significance of attribution of patented widgets.

26. The intellectual origin of dispersed knowledge and spontaneous order is traced to CARL Menger, *PRINCIPLES OF ECONOMICS* (1976).

27. The difference may be related to the fact that, while an academic journal is a long lasting serial, a book's copyright may be reassigned to another publisher a few years later.

represented by the name of a scholar, actress, or inventor stands out as the focal point of the conventions. It is similarly imaginable how hard it would be for users to purchase a music CD or for wholesalers and retailers to strike a deal, if a musician's name is forgotten. The point is that attribution represents a social organization in communicating users' wants, distributing commercial products, and facilitating social communication among users.²⁸

The economic ideas of specialization and the division of labor suggest that there is also a counterpart social organization of knowledge creation. After the specialization in printing developed, an amateur writer could just visit a printer to buy the service without using her own pen to personally write many copies of her work. With the time saved, the writer could become specialized in writing stories. On the other hand, while the firm is an economic unit of social organization, it also utilizes the benefits of specialization and the division of labor in organizing itself. For instance, knowledge creating corporations like IBM, Intel, and Microsoft have project teams whose members take some role in the six workflow steps. In a modern work environment, the number of knowledge works attributed to an employee is often the basis for job promotion or salary raise. It is also highly valued between firms because of competition in both product and factor markets. Without a proper organization of attribution, a company or research institution cannot rely on its reward system to promote more valuable outputs from its knowledge creators. Similarly, market competition for talents loses a reliable mechanism when attribution is marred with error. As reputation is important and can only be accumulated over time, the long-term stability of company growth crucially hinges on an efficacious organization of attribution, on which reputation is based.²⁹ In this light, attribution

28. Differences of concern and approach between mine and some literature on moral rights are thus clear. *See, e.g.*, Henry Hansmann & Marina Santilli, Authors' and Artists' Moral Rights: A Comparative Legal and Economic Analysis, 26 J. LEGAL STUD. 95 (1997) (arguing that moral rights permit artists to maintain a negative servitude over his work); Thomas F. Cotter, Pragmatism, Economics, and the Droit Moral, 76 N.C. L. REV. 1 (1997) (arguing that the right of integrity is indeterminate under a version of Coasian transaction cost analysis).

29. My discussion is very brief because Fisk has superbly analyzed the

of intellectual contribution has its independent value separate from intellectual property ownership and represents an indispensable social organization for both knowledge creators and users.

C. Transaction Costs and Optimal Number of Attributions

Consider the following hypothetical. After Professor *A* reminded Professor *B* that a judge wrote a paper on an issue of standing, Professor *B* got more interested and interrupted by asking who the judge was. Professor *A*, however, was only sure that it appeared in Harvard Law Review. Without the author name, Professor *A* could not be more specific and Professor *B* had no idea which article it exactly was. It suggests that the transaction cost associated with their communication was sufficiently high to make their academic exchange incomplete. Similar transaction costs would arise if they, instead, asked a research assistant to find a copy of the article. The research assistant would incur additional transaction cost when communicating it to a librarian or searching for it in a database. While my emphasis of transaction cost can go on with other examples, they are not necessary.

It is interesting to observe that Justice Antonin Scalia, in *Dastar Corp. v. Twentieth Century Fox Film Corp.*, raised a similar concern about high transaction cost.

Reading “origin” in § 43(a) to require attribution of uncopyrighted materials would pose serious practical problems. Without a copyrighted work as the basepoint, the word “origin” has no discernable limits. A video of the MGM film *Carmen Jones*, after its copyright has expired, would presumably require attribution not just to MGM, but to Oscar Hammerstein II (who wrote the musical on which the film was based), to Georges Bizet (who wrote the opera on which the musical was based), and to Prosper Mérimée (who wrote the novel on which

reward, discipline, branding, and humanizing functions of attribution. See Fisk, *supra* note 6.

the opera was based).³⁰

Justice Scalia's practical concern with "no discernable limits" helps not only pin down the court's decision, but also illuminates the need for a convention.³¹ The economic reason behind the legal citation convention is that it helps reduce transaction costs involved in communications among scholars, between scholars and their assistants, and between acquisition staffs of a library and publishers, etc. The convention involves several pieces of information. It is not unusual for legal scholars to publish more than an article a year, which have different titles and appear in different journals, and sustain a long-lasting publishing career. The hypothetical example of high transaction costs is, however, not purely related to authorial names.

High transaction costs associated with authorial attribution are more evident in communicating a journal article that involves many authors. It is growingly common that more than four or five persons are attributed as joint authors of a journal article in fields of science, engineering, medicine, and even business management.³² If an author's name was unknown or forgotten during two scholars' exchange of ideas, they would have to incur additional transaction costs before a specific article could be identified. The problem of high transaction costs is particularly acute when some, not all, authors overlap in a number of articles. It usually occurs when several combinations of intellectual collaborators are involved in theorizing and experimenting. A little arithmetic can show that, with three authors, there are seven possible ways for one to be unsure about a specific article. The

30. *Dastar Corp. v. Twentieth Century Fox Film Corp.*, 539 U.S. 23, 35 (2003) (emphasis added).

31. The "too many names" point was noticed recently and considered to be an impediment to more "Berne-Consistent" interpretation. See Graeme W. Austin, *The Berne Convention as a Canon of Construction: Moral Rights after Dastar*, 61 N.Y.U. ANN. SURV. AM. L. 111 (2005).

32. See *Canon Computer Sys., Inc. v. Nu-Kote Int'l, Inc.*, 134 F.3d 1085, 1088 (Fed. Cir. 1998) (opining that a patent was not invalid for naming 16 inventors); Walter W. Powell, *Interorganizational Collaboration in the Biotechnology Industry*, 151 J. INSTIT'L & THEO. ECON. 197 (1996) (citing an article coauthored by 45 scientists); W. B. Weeks, et al., *Changes in Authorship Patterns in Prestigious US Medical Journals*, 59 SOC. SCI. & MED. 1949 (2004).

number increases with a factorial of n , the number of authors. If there are k overlapping authors and m articles with the total number of authors being n , it will be a challenge for anyone not specialized in math to figure out how many possible ways he could forget the specific attributions in an article. Nevertheless, it is clear that transaction costs increase more than proportionately with k and n .

Attribution in the case of a motion picture is not very much different. A long list of participating actors, actresses, and production crew is usually presented at the end of a movie. Audiences would, however, pay much more attention to the much shorter list announcing, at the beginning, the director, the lead actor, and the lead actress. It indicates that the social value of the long list is far below that of the shorter list. Two technical points arise from the above examples and discussions. First, as the disproportional increase of communication costs with the number of attributions of a knowledge work suggests, the marginal transaction cost curve of an additional attribution slopes upward. Second, as the neglected long list of participating production crew suggests, the marginal social benefit curve of an additional attribution is downward sloping. Taken together, the two curves intersect each other, and the unique intersection gives the optimal number of attributions.³³ The same analysis applies to the optimal number of attributions of an invention. Thus, with many participants involved, it is inefficient to grant attribution to every participant of a knowledge project—the first element of the economic logic.

III. THE EFFICIENT BOUNDARY OF INVENTORSHIP AND AUTHORSHIP

In order to get a more definite result on whom to grant attribution in court, transaction costs associated with knowledge

33. See Terry L. Anderson & Peter J. Hill, *The Evolution of Property Rights: A Study of the American West*, 18 J. LAW & ECON. 163 (1975); Michael C. Jensen & William H. Meckling, *Specific and General Knowledge, and Organizational Structure*, in *CONTRACT ECONOMICS* 251 (Lars Werin & Hans Wijkander eds.1992), for the general approach interpreting the intersection of the marginal benefit and cost curves as optimal.

creation need to be carefully examined as well. The deepening of specialization and the division of labor as the market continues to develop reminds us of two things. First, when market competition or substitutability exists, the transaction cost associated with market exchange is significantly reduced. Second, for a variety of reasons, not everything is exchanged in the market. This Section takes up the two reminders and analyzes the attribution determination issues involved. By paying attention to the use of existing knowledge through market and the creation of new scientific or artistic knowledge through virtual transactions, I obtain the tests of market substitutability and confirmed project idea. Their two corresponding elements of economic logic, therefore, establish this Note's central proposition that intellectual contribution is the efficient boundary of inventorship and authorship.

A. Make-or-Buy Decision and Market Substitutability Test

Consider the following hypothetical case, where the knowledge work per se is not at dispute and the court is only to determine whether Ms. *A* or Mr. *B* should be attributed as the sole inventor or author. Suppose Ms. *A* paid Mr. *B* for services rendered in steps two, three, and six. That is, Ms. *A* hired a research assistant to gather data, conduct experiments, and burn a CD of the written result of the knowledge project. Suppose further that Ms. *A* independently initiated an idea for the project, confirmed the project idea after a few iterations in acquiring above services, and instantiated the confirmed project idea with a theory. Before getting into the court's decision, let us further consider that Ms. *A* could have independently performed steps two, three, and six, just as she could have paid others to perform steps one, four, and five. The question now is why she made the particular mix of make-or-buy decisions.

It brings us to Coase's point that there is a transaction cost associated with market exchange. To be sure, transaction cost and price are two separate ideas.³⁴ Emphatically, Ms. *A*'s payment was

34. Price and transaction cost were mixed up to challenge the famous Coase Theorem in a bargaining model where the parties would endlessly continue to offer and counter-offer when the offer transmission price is reduced to zero.

not her transaction cost but the price she paid for services rendered by Mr. *B*. Instead, her transaction cost could only be seen through her opportunity cost. For instance, Mr. *B* might be able to recover the confirmed project idea, like reverse engineering, through Ms. *A*'s instructions on experiments and complete the remaining instantiating and fixing steps. Thus, Mr. *B*, rather than Ms. *A*, could be in a position to proclaim sole inventorship through patent application or sole authorship through copyright registration. Were this Ms. *A*'s concern, her transaction cost in hiring Mr. *B* for the steps would be very high.³⁵ Not until specialization and market division of labor have developed to such an extent that the associated transaction cost became negligible in her own assessment, would she consider a market exchange to save her energy or time for the project. Ms. *A* outsourced steps two, three, and six and carried out steps one, four, and five alone because Mr. *B* acquired only established knowledge and could not, under her supervision, easily engage in reverse engineering to misappropriate her project.³⁶

Inasmuch as Mr. *B* claimed in court that he should be granted the right of attribution, a useful test for courts immediately comes out from the above transaction cost analysis. The test of market substitutability examines if Mr. *B*'s endeavors were substitutable in the market. If the test result is affirmative, then efficiency consideration should dictate a decision for Ms. *A*. First, as the above analysis suggests, a substitutable service in the market means that the transaction cost between Ms. *A* and Mr. *B* was low. Second, being market substitutable, knowledge associated with the

However, fully rational agents would not engage in such endless bargaining but spend time elsewhere, if the true opportunity cost were correctly modeled. The transaction cost driving the alleged "Hobbesian Theorem" thus is unspecified, but not zero. See Robert Cooter, *The Cost of Coase*, 11 J. LEGAL STUD. 1 (1982).

35. The transaction cost can be measured as the additional sum needed to secure her project from being misappropriated. It would be prohibitive if she could not effectively prevent Mr. *B* from misappropriating her intellectual contribution.

36. Supervision involves measurement and monitoring costs. See Armen A. Alchian & Harold Demsetz, *Production, Information Costs, and Economic Organization*, 62 AM. ECON. REV. 777 (1972); Yoram Barzel, *Measurement Costs and the Organization of Markets*, 25 J.L. & ECON. 27 (1982).

service has already been exploited through market specialization; therefore, it is already rewarded and needs not be further promoted. Consistent with the policy goal of promoting science and useful arts, a decision favoring Ms. *A* would help her complete the project faster or work on more projects in the same time. A decision in favor of Mr. *B*, in contrast, would promote existing knowledge in the market but not future creation of new knowledge. Thus, it is inefficient to grant attribution to whoever made nothing but market substitutable endeavors—the second element of the economic logic.

B. Virtual Transaction and Confirmed Project Idea Test

When the result of the market substitutability test is negative, it implies that Mr. *B* made at least a market non-substitutable endeavor. Another extreme case, however, might drive the negative test result. It involves the situation where Ms. *A* initiated a project idea and did nothing else but pay Mr. *B* to pursue whatever he saw fit. It necessarily implies that Mr. *B* alone performed all consistent workflow steps of the knowledge work whose attribution is at dispute. With which workflow steps was Mr. *B*'s allegedly market non-substitutable endeavor associated? Was there an intellectual contribution by Ms. *A* or Mr. *B*? And to whom should the court grant attribution, Ms. *A* or Mr. *B*? An analysis is needed before answering these questions.

In the perspective of transaction cost analysis, a knowledge creator must engage in a virtual transaction with targeted patrons in her mind. For example, they can be promoters of various artistic works, patent examiners for inventors, and journal referees for professors and researchers.³⁷ As she works and reiterates between the workflow steps trying to persuade her targeted patrons, there is a cost associated with the virtual transaction. The transaction cost is different from that associated with her make-or-buy decision alluded to earlier. It is not market substitutable and must be borne by her alone, because the virtual transaction exists only between her and the fictitious patrons she envisions.

In comparison with Coase's detailing of transaction costs in

37. General audience, consumers, or academic community are certainly a part of knowledge creators' targeted patrons.

different stages of an exchange process, she cannot realistically inform her targeted patrons that she “wishes to deal and on what terms” in the virtual transaction.³⁸ The virtual transaction is only a thought process and she cannot get a meaningful feedback from her targeted patrons until late at the end. Whether the knowledge work she envisions would satisfy her targeted patrons’ tastes, hence, cannot be tested until she has made significant investment of time and energy in completing all necessary workflow steps. Without the opportunity to communicate and bargain, the risk of losing all her investment of time and energy is very significant. The transaction cost of a virtual transaction is, therefore, much higher than that of a Coasian real exchange. The concern with the high transaction cost may inhibit her from engaging in the creation of new scientific or artistic knowledge.

The inherent high transaction cost and risk justify the constitutional promotion and protection of knowledge creators’ adventuring into virtual transactions.³⁹ Since a virtual transaction must be intellectual in nature, the analysis also shows that intellectual contributions, if any, are necessarily associated with market non-substitutable virtual transactions. As the earlier prose-writing simulation has also suggested, virtual transactions occur primarily in the steps of confirming the project idea and instantiating the consistent project idea. More importantly, without the confirmed project idea, there could not be consistent instantiation, and the virtual transaction would be unpersuasive to targeted patrons.

In light of the analysis, I return to my initial questions with another useful test—the confirmed project idea test. The test examines if Mr. *B*’s confirmed project idea was envisioned by Ms. *A*. Given that the test result was negative, Mr. *B*, not Ms. *A*, has

38. R.H. Coase, *The Problem of Social Cost*, in *THE FIRM, THE MARKET, AND THE LAW* 95, 114 (1988).

39. The protection of IP as an object for commercial exchange can help reduce the virtual transaction costs in persuading general audience, academic peers, and consumers; nevertheless, some knowledge work may not have any pecuniary benefit associated with IP. Additionally, promoters of artistic works, patent examiners, and journal referees, who control knowledge work’s access to the “market”, may have different interests and tastes from end users. Direct help through attribution protection, therefore, also encourages knowledge creators at this stage.

made the intellectual contribution. A decision in favor of Ms. *A* would therefore be contrary to the constitutionally intended purpose, because she did not bear the necessary transaction cost and risk in envisioning the consistent project and persuading her targeted patrons. Given a decision against Mr. *B*, attribution's organizational roles in reward, discipline, signaling, and reputation would all be disrupted. Without being attributed, Mr. *B*'s targeted patrons would never recognize him, and his bearing of the market non-substitutable transaction cost would have been wasteful. A decision against Mr. *B* would also deter knowledge creation otherwise available through future payees, while future Ms. *A* would still not engage in any virtual transaction necessary for knowledge creation. The test of confirmed project idea thus leads to the third element of the economic logic—it is inefficient to grant attribution to whoever only paid others for a consistent project she did not envision.

In sum, the tests of market substitutability and confirmed project idea reveal the two sides of a coin. The first test shows that market substitutable endeavors represent only the application of existing knowledge but not creation of new scientific or artistic knowledge, which, as the second test shows, is exactly the result of an intellectual contribution obtained through market non-substitutable virtual transactions. Thus, abstracting from opportunistic behaviors between intellectual collaborators, the two tests and corresponding elements of the economic logic establish that intellectual contribution is the efficient boundary of inventorship and authorship. Note that the two tests were introduced by assuming that the given knowledge work indeed contained new knowledge. Yet, there could even be a dispute over whether an inventive or authorial work contained new scientific or artistic knowledge. Nevertheless, intellectual contribution should still be what the court looks for in such a dispute, because inventorship and inventive work as well as authorship and authorial work are also two sides of the same coin—there cannot be one without the other. Intellectual contribution is, therefore, also the efficient boundary in determining invention conception and copyright originality.⁴⁰

40. The economic analysis uniquely links patent and copyright issues that have generally been considered separate and different. *See, e.g.,* Russ VerSteeg,

IV. EFFICIENT COURT STANDARDS

This Section summarizes my review of frequently cited court cases to show how judges have seemingly adopted the workflow model and the set of economic logic to develop their court standards. I begin with a summary of court determinations of invention conception in Subsection A. A summary of court standards on copyright originality is in Subsection B. They precede the summary of court standards on sole inventorship and sole authorship for two reasons. First, the validity of a patent and copyrighted work may be challenged. Second, invention conception and copyright originality are similarly not defined in the laws and courts have considered them the touchstones of patent and copyright protection.⁴¹ The two subsections show that intellectual contribution comes out clearly as the courts' established boundary of both invention conception and copyright originality. Consistent with the tests of market substitutability and confirmed project idea, intellectual contribution also comes out as the established boundary of sole inventorship and sole authorship in Subsection C.

A. Invention Conception

There are three prongs of the enduring invention conception standard of definite and permanent idea, which originated from the invention of a printing machine in the old case of *Mergenthaler v. Scudder*.⁴² First, conception is about the “mental part of the inventive act,” and there are “mental acts” toward the result to be

Intent, Originality, Creativity and Joint Authorship, 68 BROOKLYN L. REV. 123 (2002); Jackie Hutter, Note, A Definite and Permanent Idea? Invention in the Pharmaceutical and Chemical Sciences and the Determination of Conception in Patent Law, 28 J. MARSHALL L. REV. 687 (1995), for other approaches to issues of invention conception and copyright originality.

41. See *Feist Publ'ns, Inc. v. Rural Tel. Serv. Co.*, 499 U.S. 340, 347 (1991) (“Originality is the touchstone of copyright protection.”); *Burroughs Wellcome Co. v. Barr Labs., Inc.*, 40 F.3d 1223, 1227-28 (Fed. Cir. 1994) (“Conception is the touchstone of inventorship, the completion of the mental part of invention.”).

42. *Mergenthaler v. Scudder*, 11 App. D.C. 264, 276-78 (1897).

obtained and in producing that result.⁴³ If the mental part of the result to be obtained is only an idea, then confirming the idea is the corresponding mental act. The mental act in producing the result, thus, involves the instantiation of the idea through a means. Second, such mental activity must reach the level of a definite and permanent idea. It's definite and permanent when the idea "becomes so clearly defined in the mind of the inventor as to be capable of exterior expression."⁴⁴ In this sense, a confirmed project idea and its consistent instantiations are strictly distinguished from the pure act of fixing them into a tangible medium. Thirdly, the inventive idea must be complete and operative in the sense that "[a]ll that remains to be accomplished, in order to perfect the act or instrument, belongs to the department of construction, not invention."⁴⁵ Thus, the inventive idea is not complete until the instantiations include "all the essential attributes" of the invention. In addition, the pure act of fixing them into a tangible medium is excluded from the inventive acts. Consistent with the set of economic logic obtained, the three prongs clearly indicate that intellectual contribution was the court's established boundary of invention conception. It also helps understand why Justice Alvey indicated that a description or an illustration could demonstrate the completeness of the mental activity such that physical reduction to practice would be unnecessary.

The boundary of invention conception withstood further tests as technological advancement began to emerge in other fields of industrial art. Unpredictability associated with experiments and its implication to invention conception became the central issue in the case of *Smith v. Bousquet*.⁴⁶ The court held that conjecturing a particular mix of solutions did not meet invention conception because experimental results might turn out to be unexpected.⁴⁷

43. *Id.* at 276.

44. *Id.* at 278.

45. *Id.* at 276.

46. See *Smith v. Bousquet*, 111 F.2d 157 (C.C.P.A. 1940). Also see Thomas P. Nound, Mark S. Carlson, and Paul T. Meiklejohn, Patent Law Issues Affected by the Predictability of Technology in the Field of Invention, 88 J. PAT. & TRADEMARK OFF. SOC'Y 603 (2006), for a broader discussion of the unpredictability topic.

47. *Smith*, 111 F.2d at 164 (refusing to award priority date based on

Thus, when simultaneous conception is claimed, the case established that it is paramount for a claimant to show the reduction of the idea to practice by conducting experiments. The plan to carry out experiments, with uncertain results, is not enough for inventorship.

However, depending on the maturity of a particular technology, experiments may not be necessary for invention conception. Indeed, the court in *Land v. Dreyer* relaxed the standard to that which “would enable a person skilled in the art to reduce the conception to practice without any further research or exercise of the inventive skill.”⁴⁸ The reference of “a person skilled in the art” and Justice Alvey’s “department of construction” indicate that applications of existing stock of knowledge and intellectual contribution in creating new knowledge were clearly distinguished. The court in *Applegate v. Scherer* further affirmed that a sufficient disclosure through letter, even before constructive reduction, met the requirement of conception.⁴⁹ Consistent with the market substitutability test, experimental skills, unless exceptional, gradually were considered skilled art and not inventive.⁵⁰

The problem-solving orientation of the workflow model has been embraced in more recent cases involving pharmaceutical or biotechnology related invention as issues of physical reduction to practice and experiments resurfaced. In the case of *Oka v. Youssefyeh*, the court reaffirmed that being able to describe a chemical compound and being in possession of a method of making it were two different matters in the field.⁵¹ The court correctly ruled that conception required both. The court in

laboratory tests when it was still uncertain what effects would result from tests under more realistic conditions).

48. *Land v. Dreyer*, 155 F.2d 383, 387 (C.C.P.A. 1946) (emphasis added).

49. *Applegate v. Scherer*, 332 F.2d 571 (C.C.P.A. 1964); *see also Seawall v. Waters*, 21 F.3d 411, 415 (Fed. Cir. 1994); *In re Tansel*, 253 F.2d 241, 836 (C.C.P.A. 1958) (“[T]he final size and shape of every part . . . [need not] be exactly foreseen before the conception of an apparatus can be said to be complete.”).

50. *See Fina Oil & Chem. Co. v. Ewen*, 123 F.3d 1466, 1473 (Fed. Cir. 1997); *Burroughs Wellcome Co. v. Barr Labs., Inc.*, 40 F.3d 1223, 1229 (Fed. Cir. 1994).

51. *Oka v. Youssefyeh*, 849 F.2d 581, 583 (Fed. Cir. 1988).

Amgen, Inc. v. Chugai Pharmaceutical Co. opined that knowing a principal biological property was not sufficient to show the “specificity” in defining the identity of a newly discovered material.⁵² The specificity was related to Justice Alvey’s “all the essential attributes” and the workflow model’s various instantiations. The court concluded, “when an inventor is unable to envision the detailed constitution of a gene . . . as well as a method for obtaining it, conception has not been achieved until . . . the gene has been isolated.”⁵³ With similar emphasis on the specificity of the inventor’s idea, *Burroughs Wellcome Co. v. Barr Laboratories, Inc.* is particularly lucid in two additional aspects. First, the court explicitly held, “[a]n idea is definite and permanent when the inventor has a specific, settled idea, a particular solution to the problem at hand, not just a general goal or research plan he hopes to pursue.”⁵⁴ Second, the court went on to hold that “patent rights attach only when an idea is so far developed that the inventor can point to a definite, particular invention.”⁵⁵ As a whole, the court’s reference to “the definite, particular invention” and “the particular solution to the problem at hand” indicates that the boundary of invention conception was clarified in a way consistent with the workflow model’s emphasis of a problem-solving orientation toward a consistent project.⁵⁶

52. *Amgen, Inc. v. Chugai Pharm. Co.*, 927 F.2d 1200 (Fed. Cir. 1989).

53. *Id.* at 1206. Specificity also became the center of several later cases. *See Hitzeman v. Rutter*, 243 F.3d 1345 (Fed. Cir. 2001) (particle size and sedimentation rate related to hepatitis B surface antigen); *Fiers v. Revel*, 984 F.2d 1164 (Fed. Cir. 1993) (isolation of a DNA sequence); *Chiron v. Abbott Labs.*, 902 F. Supp 1103 (N.D. Cal. 1995) (nucleotide sequence of an HIV fragment).

54. *Burroughs*, 40 F.3d at 1228 (emphasis added).

55. *Id.* (emphasis added).

56. *See Invitrogen Corp. v. Clontech Labs., Inc.*, 429 F.3d 1052, 1064 (Fed. Cir. 2005) (using the “problem-solving” phraseology and citing *Burroughs*, 40 F.3d at 1229). A search of “problem solving and invention” through the LexisNexis database shows that of the 12 cases meeting the search criteria only *Invitrogen* was related to the conception issue. The remaining cases were all related to a disputant’s problem-solving mathematical algorithm, widget, or strategy.

B. Copyright Originality

The development of efficient invention conception standards was accompanied by a parallel development in holding intellectual contribution as the court's established boundary of copyright originality. The landmark case of *Burrow-Giles Lithograph Co. v. Sarony* shows that the Supreme Court seemingly adopted the workflow model to determine whether a photograph met copyright originality.⁵⁷ At the outset, the Court considered the issue to be whether photographs were "representatives of original intellectual conceptions of the author."⁵⁸ Two notable points were in the Court's findings. First, the Court distinguished mental conception and its fixing in the visible form of a picture. Second, the Court identified a number of acts, including the steps of "posing the said Oscar Wilde . . . selecting and arranging the costume . . . arranging the subject . . . arranging and disposing the light and shade, [and] suggesting and evoking the desired expression."⁵⁹

In other words, the Court examined how the photographer instantiated his confirmed project idea to produce the consistent picture. The Court established intellectual contribution as the boundary of copyright originality because the picture was not merely a "mechanical reproduction" of some object that involved no "originality of thought" or any novelty in the "intellectual operation," but the "original conception" of the author.⁶⁰ Consistent with the economic analysis, the extension of copyright protection from writings in the Constitution to photographs indicates clearly that artistic acts rather than forms constitute copyright originality and authorship.

About a hundred years later, the Supreme Court was once again faced with copyright originality in the case of *Feist Publications, Inc. v. Rural Telephone Service Co.*, where the copyright of a telephone directory was in dispute. The opinion delivered by

57. *Burrow-Giles Lithographic Co. v. Sarony*, 111 U.S. 53, 55-59 (1884).

58. *Id.* at 58 (emphasis added). This use of "intellectual conception" preceded *Mergenthaler*, the patent case which focused on the same principles, by thirteen years. It suggests that intellectual contribution has long been the focus of copyright originality.

59. *Id.* at 55.

60. *Id.* at 59.

Justice Sandra O'Connor correctly reaffirmed that only intellectual contribution beyond “sweat of the brow” or “industrious collection” deserves copyright protection. In her progression of analysis toward the Court’s decision, there were three essential points. First, in determining whether a fact-based work meets copyright originality, she opined that the focus should be on “the manner in which the collected facts have been selected, coordinated, and arranged.”⁶¹ Second, the manner in selecting and arranging the listing in the instant case, however, showed no intellectual contribution. Facts showed that the data were provided by its subscribers, and the list was in alphabetical order by surname; additionally, the manner of arrangement of the listing was “an age-old practice.”⁶² It was, thus, only “a garden-variety white pages directory, devoid of even the slightest trace of creativity.”⁶³ Whatever phrases she used in referring to the low threshold of copyright originality—“minimal degree of creativity,” “the modicum of creativity”, or “de minimis quantum of creativity”—Justice O'Connor clearly meant creativity to be exactly intellectual contribution. It was so because she has specifically linked the “minimum degree of creativity” of *The Trade-Mark Cases* with the “intellectual production, of thought, and conception” of *Burrow-Giles*.⁶⁴

And third, her elucidation against the flaws of the doctrine of “sweat of the brow” or “industrious collection” was in perfect consistency with the workflow model’s emphasis on the distinction between market substitutable endeavor and market non-

61. *Feist Publ’ns, Inc. v. Rural Tel. Serv. Co.*, 499 U.S. 340, 358 (1991) (emphasis added).

62. *Id.* at 363.

63. *Id.* at 362, 363 (emphasis added).

64. *The Trade-Mark Cases*, 100 U.S. 82 (1879). Nevertheless, the use of creativity was imprecise and confusing. See, e.g., *Goldstein v. California*, 412 U.S. 546, 561 (1973) (using creative intellectual or aesthetic labor); *Baltimore Orioles, Inc. v. Major League Baseball Players Ass’n.*, 805 F.2d 663, 668 (7th Cir. 1986) (stating that a copyrightable work “must be original and creative, but need not be novel”); *West Publ’g Co. v. Mead Data Cent., Inc.*, 799 F.2d 1219, 1225 (8th Cir. 1986) (using originality and intellectual-creation as dual requirements); *Am. Dental Ass’n v. Delta Dental Plans Ass’n*, 39 U.S.P.Q.2d (BNA) 1714, 1720 (N.D. Ill. 1996) (stating that imagination serves as the touchstone of creativity), *vacated*, 126 F.3d 977 (7th Cir. 1997).

substitutable intellectual contribution. Sweat of the brow in gathering, selecting, coordinating, and arranging preexisting data in the instant case was nothing but market substitutable endeavor. Seemingly sifting through all the workflow steps, she concluded that “copyright rewards originality, not effort.”⁶⁵ Thus, at the opposite end of the spectrum from *Burrow-Giles*, *Feist* was a case showing no intellectual contribution in printed materials at all. In perfect consistency with the economic logic, the two contrasting cases, almost one hundred years apart, show the two sides of the efficient boundary of copyright originality.

C. *Sole Inventorship and Authorship*

The above findings suggest that intellectual contribution should come out as the courts’ established boundary of sole inventorship and sole authorship as well. The summary of case reviews on inventorship and authorship can thus be made succinct here for two reasons. First, cases on invention conception and copyright originality show similar court findings concerning inventorship and authorship; therefore, reporting of intellectual contribution findings would only be repetitious. Second, since the efficient boundary of intellectual contribution is argued without considering opportunistic behaviors between two intellectual collaborators, a review of joint inventorship and authorship cases deserves separate, full attention elsewhere.⁶⁶ Inasmuch as court inventorship and authorship standards of mere suggestion, mere conception, and employee improvement are directly related to market substitutability and confirmed project idea tests, this subsection focuses on showing how perfectly consistent with the economic logic and efficient they are.

To begin with, the court in *Seshadri v. Kasraian* opined that the help from a research assistant, secretary, draftsman or commenting

65. *Feist*, 499 U.S. at 364.

66. My empirical studies reveal that inefficiency only occurred much more recently in joint authorship standards developed after the Copyright Act of 1976. The source of inefficiency is related to opportunistic behaviors lurking in intellectual collaboration and institutional differences between copyright law and patent law. See Steven S. Kan, *Court Standards on Joint Inventorship and Authorship*, 19 DEPAUL J. ART, TECH., & INTELL. PROP. L. 17 Part IV (2009).

colleague in the preparation of a scholarly paper did not entitle the helper to claim the status of a joint author.⁶⁷ Apparently consistent with the market substitutability test, the kind of help does not constitute authorship because there is no intellectual contribution. In the more complicated case of *Polye v. Uhl*, the litigants were friends and they separately filed patent applications.⁶⁸ The court found that Uhl had suggested to Polye several ways to possibly solve his problem but had not even vaguely referred to “[t]he amount to be used, the nature and composition of the electrolyte, and the question of whether or not a catalyst would be required.”⁶⁹ The court thus concluded that Uhl could not be an inventor because he only showed “mere existence of an intellectual notion that a certain thing could be done, and, if done, might be of practical utility.”⁷⁰ A careful reading of the case confirms that the decision was in perfect consistency with the market substitutability test, because Uhl’s suggestions to Polye’s problem were picked up from a reference book and a handbook.

The related standard of mere conception was established in *Forgie v. Oilwell Supply Co.*⁷¹ Forgie approached Barrett to discuss problems of drilling tools and suggested that a lifting jack could in some manner be utilized to help couple and uncouple a drill rod. Barrett later successfully came up with a new drilling tool. Forgie, nevertheless, filed a patent application and sued Barrett for patent infringement. The court opined that the plaintiff, when approaching the defendant, “had no definite plan in his mind; that he was in pursuit of information and aid; that various plans were talked about; and that finally the conclusion was that Barrett’s jack, to be altered as Barrett suggested, was the one that would do the work.”⁷² Thus, Forgie only initiated a problem to Barrett but did not show any intellectual contribution; the confirmed project idea and the consistent instantiations were all

67. *Seshadri v. Kasraian*, 130 F.3d 798 (7th Cir. 1997).

68. *Polye v. Uhl*, 328 F. 2d 893 (C.C.P.A. 1964).

69. *Id.* at 898.

70. *Id.* (quoting *Standard Cartridge Co. v. Peters Cartridge Co.*, 77 F. 630, 645 (6th Cir. 1896)). There exist many similar cases of mere suggestions between friends, co-workers, or employers. *See, e.g., O'Donnell v. Hartt*, 75 F.2d 195 (C.C.P.A. 1935).

71. *Forgie v. Oilwell Supply Co.*, 58 F. 871, 877 (3d Cir. 1893).

72. *Id.* at 876.

Barrett's.

Both market substitutability and the confirmed project idea tests were involved in the very old patent infringement case of *Agawam Co. v. Jordan*, where the defendant alleged that the true inventor was not the patentee but his employee.⁷³ The Court's decision was efficient and accorded well with the market substitutability test. The case was also known for establishing the standard of "employee improvement." It means that "no suggestions from an employee, not amounting to a new method or arrangement, which, in itself is a complete invention, is sufficient to deprive the employer of the exclusive property in the perfected improvement."⁷⁴ In other words, an employer cannot be an inventor if the employee developed an independently patentable invention outside of the scope of the employer's conceived plan.

Misapplication of the standard of mere suggestion by the lower court occurred in the copyright case of *Andrien v. Southern Ocean County Chamber of Commerce*, where Andrien, the plaintiff, engaged Carolyn Haines to do the artwork for a compilation of preexisting maps and other information assembled.⁷⁵ The lower court held that Andrien only supplied information and ideas and it was Haines who translated the ideas into a fixed, tangible expression. The appellate court correctly overruled by finding that "none of Haines' activities in any way intellectually modified or technically enhanced the concept articulated by Andrien."⁷⁶ Since Andrien already envisioned a project and only needed help for fixing it in a tangible medium, the appellate court properly applied both the market substitutability and confirmed project idea tests.

The case of *Whelan Associates, Inc. v. Jaslow Dental Laboratory, Inc.* involved a custom-made business management software program, and the defendants claimed sole ownership on the ground that the plaintiff was a contractor to develop the work.⁷⁷ Going through the workflow steps, the court opined, "Such general

73. *Agawam Co. v. Jordan*, 74 U.S. 583 (1868).

74. *Id.* at 603.

75. *Andrien v. S. Ocean County Chamber of Commerce*, 927 F.2d 132, 133 (3d Cir. 1991)

76. *Id.* at 135.

77. *Whelan Assocs., Inc. v. Jaslow Dental Lab., Inc.*, 609 F. Supp. 1307 (E.D. Pa. 1985).

assistance and contributions to the fund of knowledge of the author did not make [defendant] a creator of any original work, nor even the co-author.”⁷⁸ As in any commissioned work, one who commissions must provide necessary information before a contractor can take up the problem and come up with a customized solution. The court’s decision was perfectly consistent with the economic logic—it is inefficient to grant attribution to whoever did nothing but paid others for a consistent project she did not envision.⁷⁹

In sum, the above case reviews show perfect consistency between the economic logic obtained and court established standards. Though intuitively appealing, the proposition that intellectual contribution is the efficient boundary of inventorship and authorship is for the first time shown theoretically and empirically.

V. CONCLUSION

The confirmed project idea of this Note is to shed light on how judges have contributed to the development of the United States into the world’s top knowledge center in the twentieth century. An economic analysis based on the workflow model of knowledge creation and a review of frequently cited cases form two parts of the consistent project. The economic analysis is instantiated with attribution’s organizational value separate from intellectual property ownership, the distinction between a virtual transaction and a Coasian real exchange, and the clarification between market substitutable endeavor and intellectual contribution via virtual transaction. The set of economic logic obtained establishes that intellectual contribution is the efficient boundary of invention conception and inventorship, and copyright originality and authorship. The case reviews are instantiated through a special attention to the process-centered and problem-solving oriented workflow steps. The reviews show that, consistent with the economic logic, judges have successfully established intellectual

78. *Id.* at 1318.

79. *See also* Geshwind v. Garrick, 734 F. Supp. 644 (S.D.N.Y. 1990) (involving the creation of an animated film), *vacated in part*, 738 F. Supp. 792 (S.D.N.Y. 1990).

contribution as the efficient boundary of invention conception, copyright originality, sole inventorship, and sole authorship.

The consistent project is thus accomplished to help appreciate how judges have contributed in protecting true inventors and authors making intellectual contributions. Notably, the cases reviewed span a long period during which law and economics were unknown to judges. Nevertheless, they insisted in examining acts associated with knowledge creation rather than forms of knowledge work, discerning structural changes of technological progress and economic development, and in distinguishing market substitutable endeavors from virtual transactions leading to intellectual contribution. American judges thus have remarkably served the Constitution's purpose in promoting science and useful arts. Though dwarfed by the judges' success in developing these efficient court standards, the law and economic analysis presented in this Note represents a useful, succinct reconstruction of their legendary intellectual contributions for lasting protection of true inventors and authors in the future.