

Fair Division of the Profit from Collaboration in Markets for Intellectual Property

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INTRODUCTION

Collaboration is common in markets for intellectual property.¹ There are many famous teams of songwriters. Most patents list more than one inventor. The movie and software industries rely on complex collaboration to create their intellectual products. Movies require collaboration between the producer, director, actors, editor, cinematographer, writers, etc. Software development often requires the collaboration of many programmers. Collaboration is not limited to the creation of new intellectual property; inventors and authors collaborate to improve patented inventions and transform copyrighted works.²

Successful collaboration yields profit³ that is shared among collaborators. Joint inventors and joint authors often share profit equally,⁴ but they also use assignment and licensing contracts to devise other sharing schemes.⁵ Collaborators usually discuss their intentions regarding profit sharing in advance, but sometimes those discussions are vague or incomplete, and sometimes there simply is no discussion of profit-sharing at all.⁶ When collaborators fail to clearly specify sharing rules in advance then they have to agree on a sharing method after the intellectual property has been created. In many cases the collaborators fail to reach an agreement and a court has to decide how to divide the profit. Courts reach their decisions by determining who among the collaborators owns the copyright or patent in question, whether any of the collaborators is an infringer, and how to interpret actual or implicit licenses. I argue that collaborators generally intend to fairly

¹ See Rochelle Cooper Dreyfuss, *Collaborative Research: Conflicts on Authorship, Ownership, and Accountability*, 53 VAND. L. REV. 1162, 1166 (1999) (noting increased prevalence of collaborative production); F. Jay Dougherty, *Not a Spike Lee Joint? Issues in the Authorship of Motion Pictures Under U.S. Copyright Law*, 49 U.C.L.A. L. REV. 225, 282-313 (2001) (explaining that movies are created through the collaborative contributions of producers, screenwriters, cinematographers, editors, performers, designers, musicians, and directors).

² My working definition of collaboration requires that collaborators make contributions that are integrated to form a whole; the value of their individual contributions cannot be determined easily. I focus on collaboration rather than other types of cooperation because collaboration raises interesting questions about the fair division of profit. In other types of productive arrangements fair division is secondary to market forces in determining profit shares.

³ Profit is defined by economists as the excess of revenue over the sum of inputs costs plus the normal rate of return on investment.

⁴ In a sense, equal sharing is the default rule under copyright and patent law. Joint inventors and joint authors are co-owners of their patents or copyrights. Joint copyright owners can demand an accounting and recover an equal share of profits from co-owners, but joint patent owners do not have such a right. Joint patent ownership implies an equal sharing of profit only if each owner has identical opportunities to profit from the patent. For further discussion see *infra* x.

⁵ See e.g., *Papa's-June Music, Inc. v. McLean*, 921 F. Supp. 1154, 1158-60 (S.D.N.Y. 1996) (a song-writer and lyricist apparently had an agreement to a 70/30% split of royalties).

⁶ Sometimes collaborators fail to recognize their collaboration or disagree about the significance of each party's contribution. There are cases in which collaborators did not foresee the development of a new technology, the emergence of a new use, or changing economic conditions that upset the original sharing arrangement. In other cases, the collaborators do not recognize their collaboration in advance, or do not acknowledge a collaborator in advance. Finally, there are cases in which the collaborative project creates intellectual property with unexpected qualities. [Social norm.] F. Jay Dougherty, *Not a Spike Lee Joint? Issues in the Authorship of Motion Pictures Under U.S. Copyright Law*, 49 U.C.L.A. L. REV. 225, 281 (2001) 317 (mistakes and unforeseen contributions prevent ex ante contracting from completely allocating ownership rights).

divide the profit from collaboration, and that courts should resolve such conflicts by implementing a fair division unless there is strong evidence the parties shared some other intent.⁷

In practice, courts consider a variety of factors when deciding how to divide profit among collaborators, but fair division is a primary concern.⁸ The importance of fair division is not surprising because judges rely heavily on equitable principles when fashioning remedies in intellectual property cases.⁹ Intellectual property law scholars have recently urged courts to use their equitable powers more creatively to better implement the goal of fair division of profit among collaborators.¹⁰

Despite its importance, intellectual property law courts and scholars have not articulated a rigorous theory of what constitutes fair division. When they have explicitly discussed fair division they have relied on Aristotle's proportional method.¹¹ The

⁷ The standard view requires courts to supply contract terms that parties would have agreed to had they considered the issue at the time of contracting. See, e.g., Richard A. Posner, *Economic Analysis of Law* 82 (3d ed. 1986); Charles J. Goetz & Robert E. Scott, *The Mitigation Principle: Toward a General Theory of Contractual Obligation*, 69 Va. L. Rev. 967, 971 (1983). In the copyright context see Scott J. Burnham, *The Interstices of Copyright Law and Contract Law: Finding the Terms of an Implied Nonexclusive License in a Failed Work for Hire Agreement*, 46 J. Copyright Soc'y U.S.A. 333, 367 (1999) (A court should supply terms by constructing "either a hypothetical agreement or a reasonable agreement, either the terms the parties would have negotiated had they contemplated a nonexclusive license or the terms that we supply using principles of fairness and reasonableness."); cf. CHARLES FRIED, *CONTRACT AS PROMISE* 57-73 (1981) (using fairness to justify a contract default rule of sharing in the case of impracticability or mistake).

⁸ Part IV addresses other prominent concerns about the division of profit: the impact on the incentive to market the intellectual property; the impact on future incentives to collaborate; and the desire to punish bad faith behavior by one collaborator toward another. Several courts have identified fair division as a key issue in resolving disputes between collaborators. See e.g., *Fishing Concepts, Inc. v. Ross*, 1985 WL 1549, 226 U.S.P.Q. 692, at *8 (D. Minn. May 16, 1985) (assessing fair division of profit based on dissolution of partnership in which key assets were trade secrets, and copyrighted software and marketing material); *Hamil America Inc. v. GFI*, 193 F.3d 92, 104-06 (2nd Cir. 1999) (discussing fair allocation of defendant's overhead when determining division of profit in copyright infringement case). Cf. *U.S. v. ASCAP*, 1993 WL 60687, 1993 Copr.L.Dec. P 27,088 (S.D.N.Y. Mar 01, 1993) (seeking fair allocation of ASCAP royalties among song-writers); S.C. Johnson ("fair allocation" of litigation costs to patent plaintiffs and defendants).

⁹ See e.g., Wendy J. Gordon, *On Owning Information: Intellectual Property and the Restitutionary Impulse*, 78 Va. L. Rev. 149, 261 (1992) (favoring a damage remedy for intellectual property misappropriation actions whereby the plaintiff may recover "the amount of the defendant's profit that is fairly allocable to the contribution made by the plaintiff's work."); Gregory Donat, *Fixing Fixation: A Copyright with Teeth for Improvisational Performers*, 97 COLUM. L. REV. 1363, 1403 (1997) (opposing equal sharing of profits in the context of performers' contributions to a copyrighted work); Paul Edward Geller, *Hiroshige vs. Van Gogh: Resolving the Dilemma of Copyright Scope in Remedying Infringement*, 46 J. COPYRIGHT SOCIETY 39, 65 (1998) (advocating apportioning "compensatory awards to the extent to which plaintiff's work contributes to the appeal of defendant's on the market place."); F. Jay Dougherty, *Not a Spike Lee Joint? Issues in the Authorship of Motion Pictures Under U.S. Copyright Law*, 49 U.C.L.A. L. REV. 225, note 306 (2001) (suggesting "each contributor is entitled to a payment that reflects the importance of her contribution relative to the motion picture as a whole."); Roberta Rosenthal Kwall, *"Author-Stories": Narrative's Implications for Moral Rights and Copyright's Joint Authorship Doctrine*, 75 SO. CAL. L. REV. 1, 58 (2001).

¹¹ Apportioning the defendant's profits is appropriate. See *Sheldon v. MetroGoldwyn Pictures Corp.*, 309 U.S. 390, 399- 402 (1940); Tigran Guledjian, Note, "Teaching the Federal Circuit New Tricks: Updating the Law of Joint Inventorship in Patents," 32 Loy. L.A. L. Rev. 1273, 1299 (1999). "Choi should be entitled to two out of the fifty-five claims, or 3.64% of the entire ownership rights in the patent. If the patent is

proportional method rewards collaborators based on individual merit. This Article presents two alternative methods of fair division derived from cooperative game theory, and motivated by problems with the proportional method. One method is called the Shapley value. Like the proportional method, the Shapley value rewards collaborators based on a measure of their merit, but it also rewards beneficial collaborative interaction. The other method is called the nucleolus. This method works to minimize discontent experienced by individuals and subgroups within the collaborative venture.

Deriving fair division methods from cooperative game theory has two advantages over traditional ad hoc analysis. First, the Shapley value and the nucleolus can be characterized in terms of primitive moral axioms. In other words, there is a set of value statements (axioms) that are simultaneously and uniquely satisfied by the Shapley value. Similarly, there is a different set of value statements characterizing the nucleolus. An axiomatic characterization of two division methods allows one to compare the normative appeal of the methods by comparing their constitutive axioms. Second, cooperative game theory incorporates information about interactions in multi-party collaboration that traditional analysis ignores.

The following example illustrates a multi-party fair division problem that can be fruitfully analyzed using methods from cooperative game theory. Suppose Archimedes, Bell, and Carver collaborate to create and market an invention. Bell and Carver have exclusive control over distinct inputs that can be used by Archimedes to create a patentable invention. If Archimedes collaborates with Bell and Carver then the invention generates a profit of \$9 million.¹² If Archimedes and Bell, or Archimedes and Carver collaborate as a pair then the invention generates a profit of \$6 million. If Bell and Carver collaborate as a pair they get nothing. Finally, any one of three, acting alone, gets nothing.

What are plausible candidates for fair division of the profit in this example? Impartiality requires that Bell and Colt get the same share, since they play symmetric roles in the collaboration. It is not clear though how much Archimedes should get compared to the other two. The Aristotelian method divides the wealth in proportion to individual merit, but there is no indication of individual differences in talent, or effort, or other traditional measures of merit — thus, the Aristotelian method stipulates equal shares of \$3 million. In contrast, the Shapley value and the nucleolus both give a larger share of the profit to Archimedes. The Shapley value gives \$5 million to Archimedes and \$2 million to Bell and Carver. The nucleolus gives \$6 million to Archimedes and \$1.5 million to Bell and Carver. I will explain the derivation of these outcomes in Part III.C; the message at this point is simply that the cooperative game theory methods account for the positive interaction between Archimedes and the others, and give Archimedes a larger share of the profit.

successful and yields income, Choi should be entitled to 3.64% of that income and no more, for he should not benefit from the fruits of another.” Rochelle Cooper Dreyfuss, Collaborative Research: Conflicts on Authorship, Ownership, and Accountability, 53 VAND. L. REV. 1162, 1220 (1999) (proposing a new category of collaborative works that gives “each author pecuniary interests in the work proportional to that party’s input.... Authors’ rights to exploit and make derivative use of the product would also be divided proportionately.”) [Dreyfuss only applies this category to works that are not for hire and are not joint (because they don’t meet the unitariness requirement.)]

¹² The \$9 million is calculated after each party is reimbursed for the direct costs of invention.

This Article contains four parts. Part I describes circumstances when fair division rather than incentives guide profit division by collaborators. Even though the courts have considered many cases presenting problems of fair division, the jurisprudence on this problem remains thin. Courts usually choose all-or-nothing or equal-split allocations to divide profit among joint inventors and joint authors. Courts are more ambitious in cases involving cumulative creation. They have apportioned damages or used implied licenses to implement a more nuanced division of profit among cumulative creators. Part II develops several normative principles of fair division that may be applied to collaboration in markets for intellectual property. Taken as a whole the principles are mutually inconsistent — we cannot guarantee any method will always satisfy all of the principles. Some fair division problems force us to choose between these principles. The choice of a method of fair division reveals how much weight a commentator or a court gives to the conflicting principles. Part II also provides the axiomatic foundation of the Shapley value and nucleolus. Axiomatic analysis reveals that the Shapley value is best understood as merit-based methods of fair division that generalizes the proportional method. In contrast, the nucleolus is built up from a consistency axiom that captures values associated with competition and voluntary bargaining. Part III demonstrates that divergent notions of what constitutes fair division account for conflicting views about the proper copyright and patent law treatment of minor collaborators. The nucleolus is used to defend current law that is not very generous toward minor collaborators. In contrast, the Shapley value is used to defend the view that minor collaborators deserve a proportional share of the profit from a copyright or patent. Part III also provides guidance for apportionment of damages in cases of cumulative creation. Part IV addresses the question of whether attention to fair division will cause courts to subvert economic efficiency, and the question of how to integrate other notions of fairness into this cooperative game theory based analysis.

I. FAIR DIVISION PROBLEMS IN INTELLECTUAL PROPERTY LAW

A. Collaboration Defined

Most intellectual property arises from cooperation not solitary effort. Nevertheless, many commentators have noticed that patent and copyright law venerate the work of the lone genius as crucial to the progress of the arts and sciences. The rhetoric of patent law is crafted to match the image of the eccentric inventor working alone in his garage. The rhetoric of copyright law is crafted to match the image of the starving artist working alone in his garret. These romantic images have a grip on the law that is disproportionate to the actual instances of solitary genius.¹³ Really, most of the progress in arts and sciences is achieved through some mode of cooperation. That cooperation may take a modest form, for example, an inventor purchases components for his invention from a semiconductor fabricator, or an artist gets advice from a paint

¹³ Jessica Litman, *The Public Domain*, 39 Emory L. J. 965 (1990), disparages the romantic notion of authorship that suggests that authors create works out of thin air. In reality, authors build on many earlier sources. The building process involves some sort of copying and reworking that result in a transformation of existing expression. See also JACK STILLINGER, *MULTIPLE AUTHORSHIP AND THE MYTH OF SOLITARY GENIUS* (1991); Peter Jaszi, *On the Author Effect: Contemporary Copyright and Collective Creativity*, 10 CARDOZO ARTS & ENT. L.J. 293, 302 (1992); Martha Woodmansee, *On the Author Effect: Recovering Collectivity*, 10 CARDOZO ARTS & ENT. L.J. 279 (1992).

supplier about the characteristics of different paints. Cooperation may take an impersonal form, for example, an inventor creates a new chemical compound that is sold to various firms that use it to make an adhesive. I am interested in collaboration — personal and substantial cooperation like the collaboration between a composer and a lyricist.

I define collaboration to be a form of cooperative production that is characterized by *team production* and *thin input markets*.¹⁴ Team production occurs when two or more agents contribute something of value to the production of a single output and it is difficult to attribute a definite portion of the final output to the contribution of each agent. The requirement of thin markets simply means that each collaborator has some market power. Collaborative creation of intellectual property usually exhibits both of these characteristics: individual contributions are hard to assess;¹⁵ and the specialized talent or information possessed by each collaborator gives them market power.

What motivates my emphasis on team production and thin markets in my definition of collaboration? These factors combine to create some latitude for collaborators to choose how to divide profit and still achieve efficiency. Team production creates surplus and social conditions favorable to cooperative behavior. Thin input markets create bargaining problems that can be solved if collaborators can agree on a fair surplus division.

The presence of team production reduces the likelihood that profit division is simply a contest for the largest possible share. Team production implies that a collaborator cannot easily identify the share of profit that he or she contributed. If collaborators have trouble identifying individual contributions, then they are likely to think more about a fair division of profit. Conversely, when each collaborator's contribution is easily identified that contribution is likely to serve as a benchmark for the minimal "fair" share for each agent. Absent team production, cooperating agents might care about fairness, but the problem is uninteresting if the fair division simply matches everyone's individual contribution.

The presence of thin markets means that profit division is not fixed by market forces. In the thick markets described in textbooks, the question of the fair division of profit never arises — profit division is either outside the control of agents or simply a contest for the largest possible share. In a competitive market transaction the equilibrium price is the instrument that is used to divide profit between buyers and sellers. By assumption the participants in a competitive market cannot control the price; therefore, they cannot control profit division. In a monopolistic market transaction the price is controlled by the seller who chooses the price to capture as much profit as possible.¹⁶ There is no consensus about how to model bargaining or other transactions in thin markets. The traditional approach is to model price setting as a struggle between the

¹⁴ My notion of collaboration adds the requirement of thin input markets to the requirement of team production because I want to exclude teams including relatively unspecialized inputs. The classic example of team production as described by Alchian and Demsetz was a team of workers unloading a ship. Robert P. Merges, *The Law and Economics of Employee Inventions*, 13 *Harv. J. Law & Tech.* 1 (1999). 20-22 Research as team production. A recent account of the economics of team production as applied to corporate law appears in Margaret M. Blair & Lynn A. Stout, *A Team Production Theory of Corporate Law*, 85 *VA. L. REV.* 247 (1999).

¹⁵ Courts have commented on the difficulty of measuring how much value each collaborator contributed.

¹⁶ There is evidence that monopolists choose prices below the profit maximizing price because of concern about consumers' perceptions of unfairness.

parties to achieve the most profit. The greater share goes to the party with the greater bargaining power.

Mainstream microeconomic theory now recognizes that fair profit division plays a role in bargaining situations.¹⁷ A selfish struggle for the largest possible profit share may cause inefficient delay or bargaining breakdown. Norms of fair division can temper the struggle and improve efficiency. Virtually any pattern of profit division can be derived as an equilibrium of a bargaining game. Given this indeterminacy, bargainers are apt to use fairness norms to select an equilibrium outcome.¹⁸ Experimental evidence confirms the importance of fairness in predicting bargaining outcomes.

To illustrate the importance of collaboration for a rich discussion of profit sharing let me return to the romantic vision of the starving artist. The starving artist might not collaborate, but he is not autarkic like Robinson Crusoe; he cooperates with people who supply him with paint, brushes, and other supplies. None of these parties really collaborates with the painter, though. They all interact with him through relatively competitive markets involving standard goods and services. The painter captures the entire profit from the sale of the painting. The art supplies company gets the same payment regardless of how successful the artist is, or the sale price of his painting.¹⁹

B. *Fair Division in Patent and Copyright Law*

Fair division problems arise in a special subset of intellectual property cases. The typical intellectual property case features a defendant who uses intellectual property (allegedly created by the plaintiff) in competition with the plaintiff. Courts reflexively protect a victorious plaintiff from unfair competition and impose strong remedies including injunctive relief,²⁰ and damages that are sufficient to deter future infringement.²¹ In contrast, successful plaintiffs in the cases discussed in this Article are less likely to win strong remedies. Instead, courts are sensitive to the need to fairly divide the profit from collaboration between the plaintiff and the defendant.²²

¹⁷ Some microeconomists insist that fairness is only a normative issue. They might recommend that an arbitrator or judge choose a fair solution to a bargaining problem. Other microeconomists find a normative and positive role for fairness. They might argue that a particular bargaining solution is likely to be chosen by private parties because it is fair. Given the indeterminacy of game theoretic models of bargaining, one can argue that bargainers might reasonably select a fair outcome as a focal point.

¹⁸ For example, the Nash bargaining solution picks a particular fair surplus division for each bargaining problem. The Nash bargaining solution is a popular method of analyzing bilateral monopoly. Nash created a list of four axioms that he thought a fair bargaining solution should satisfy.

¹⁹ Surplus division between the painter and the buyer is a different matter. The exchange creates surplus but it is certainly not collaborative. The market for fine art might be thin, but team production is missing. The parties could use some fairness norm to avoid bargaining inefficiencies, but a struggle for the largest share of surplus is likely. This struggle is socially accepted, especially if the parties are strangers engaged in a one-time transaction.

²⁰ See Paul M. Janicke, *Side Bar: Remedies for Patent Infringement*, in DONALD S. CHISUM, ET AL., PRINCIPLES OF PATENT LAW: CASES AND MATERIALS 1223-24 (2001).

²¹ Courts are also willing to impose punitive damages in the case of willful infringement.

²² "Equity is concerned with making a fair apportionment so that neither party will have what justly belongs to the other." *Sheldon v. Metro-Goldwyn Pictures Corp.*, 309 U.S. 390, 408 (1940). An infringer is entitled to apportion the infringing profit only when "the evidence is sufficient to provide a fair basis of division so as to give the copyright proprietor all the profits that can be deemed to have resulted from the use of what belonged to him." *Sheldon v. Metro-Goldwyn Pictures Corp.*, 309 U.S. 390, 402 (1940).

Two types of fair division cases are discussed in this Article. First, there are disputes about authorship and inventorship, and related disputes about joint copyright or patent ownership.²³ In a typical case, the plaintiff seeks a declaration of patent or copyright ownership, and an accounting of profits in the copyright cases.²⁴ Second there are disputes about whether the collaborators have permission to use pre-existing intellectual property, or whether they exceeded the scope of their permission. The plaintiff usually seeks an injunction against future infringement and recovery of damages for past infringement. In many copyright cases, the two claims blend together because it is not clear whether the plaintiff created a pre-existing work or simultaneously contributed to the collaboration as a joint author.

Authorship and inventorship disputes arise when one collaborator asserts joint copyright or patent ownership rights to gain a share of the profit arising from joint creation of the intellectual property.²⁵ The defendant typically denigrates the contribution of the plaintiff and asserts he is entitled to sole ownership. The definition of inventorship or authorship is the key to determining who initially owns a patent or copyright. The inventor is defined to be the first person or group of persons to conceive of the invention.²⁶ Patent law vests ownership of a patent with the inventor.²⁷ An author is a person (or group of persons) who makes a fixed and original expressive work.²⁸

²³ Another category of cases arises because some technical change or other unforeseen contingency opens a new market for the intellectual property, and the collaborative agreement does not clearly specify who is entitled to the profit derived from the new market. Several disputes over new use arose when movies were copied and distributed on videotape. For example, in *Disney v. Boosey & Hawkes* and *MGM v. Cohen* music composers sued movie studios claiming they did not authorize the studios to incorporate their music in the video version of the movie. The composers claimed their licenses were limited to movies recorded and distributed in conventional reels. The court in *Boosey & Hawkes* sided with the composer, and the court in *Cohen* sided with the movie studio.

²⁴ An accounting of profit is not available as a remedy in patent cases.

²⁵ See e.g., x. Mixed in with these typical disputes are cases in which a non-collaborator (rent-seeker) seeks to capture some of the profit from the intellectual property. See e.g., x. And cases in which the patent or copyright owner acts in simple bad faith toward an author or inventor. See e.g., *Stark v. Advanced Magnetics, Inc.*, 29 F.3d 1570, 1575-76 (Fed. Cir. 1994) (A doctor with a long-term collaboration with medical device company asserted the company intentionally and wrongly omitted his name as inventor or joint inventor of a patented invention.); *University of Colorado Foundation, Inc. v. American Cyanamid Co.*, 196 F.3d 1366, 52 USPQ2d 1801 (Fed. Cir. 1999), cert. denied, 529 U.S. 1130 (2000), on remand, 105 F. Supp. 1164, 55 USPQ2d 1909 (D. Colo. 2000) (Two academic researchers reformulated Cyanamid's prenatal vitamin and mineral supplement. They disclosed the new formula to Cyanamid, and the company applied for a patent naming a company researcher as the sole inventor. The district court found the academic researchers were the true inventors, and held Cyanamid liable on an unjust enrichment claim.)

²⁶ See *Burroughs Wellcome Co. v. Barr Lab., Inc.*, 40 F.3d 1223, 1227 (Fed.Cir.1994), cert. denied, 516 U.S. 1070 (1996) ("A joint invention is the product of a collaboration between two or more persons working together to solve the problem addressed.")

²⁷ Only one patent can be granted on each invention. A patent is awarded to the first inventor when multiple inventors claim a patent on the same invention. An invention is patentable if it is new and nonobvious.

²⁸ Fixation and originality are not stringent requirements. Recording an expression in some medium satisfies the fixation requirement, e.g., simply writing text on paper constitutes fixation. Independent creation and a minimal amount of creativity satisfy the originality requirement. See Feist; Jessica Litman, *The Public Domain*, 39 Emory L. J. 965 (1990). The originality requirement has a constitutional basis coming from the phrase "writings of authors" in the copyright clause. We equate originality with authorship and interpret original as "owing its origin to an author." The requirement that a work is expressive is more significant. Copyright law is careful to exclude ideas from protection.

Copyright law vests ownership of a copyright with the author unless the work made for hire doctrine applies in which case ownership vests with the author's employer.

If the plaintiff is successful then joint ownership entitles her to equal rights in exploiting the copyright or patent,²⁹ and in the case of copyright, an accounting and equal share of the profits already earned by the copyright owner.³⁰ Thus the default rule³¹ under copyright law is basically equal sharing of the profit derived from the copyright among the authors, and under patent law the default rule leads to equal sharing of expected profit among inventors only if each inventor has equal access to use and licensing opportunities.³²

Many inventions and works of authorship incorporate significant features of earlier patented inventions or copyrighted works.³³ For example, inventors add new features and improve components of a patented machine, and they find new uses for patented chemicals.³⁴ Movie producers incorporate copyrighted music into movie soundtracks and copyrighted novels into screenplays. There are two intellectual property law features that have a critical influence on cumulative creation: (1) a later creation may infringe an earlier patent or copyright; and (2) a later creation may be eligible for a patent or copyright. Both patent and copyright law allow the owner of the rights to the original creation to sue a later creator for infringement.³⁵ Patent and copyright law differ with regard to protection of the later creation. Any invention that is novel and nonobvious is eligible for patent protection, regardless of whether it builds on other patented inventions.

²⁹ Given joint ownership the parties are free to individually exploit their patent or copyright. *See* 15 U.S.C. x (patent ownership) and 17 U.S.C. x (copyright ownership). *See* *Merges supra* note x at 19-20

³⁰ Under copyright law the parties must account to one another for profits derived from the copyright. There is no corresponding duty under patent law. *See* Rochelle Cooper Dreyfuss, *Collaborative Research: Conflicts on Authorship, Ownership, and Accountability*, 53 VAND. L. REV. 1162, 1212 (1999).

³¹ This is a default rule in the sense that parties are free to negotiate some other sharing scheme in advance. These disputes arise because the parties failed to bargain in advance, or the terms of the bargain are unclear.

³² 1 Melville B. Nimmer & David Nimmer, *Nimmer on Copyright* §6.08, at 6-28 (co-authors get an equal share regardless of each co-authors relative contribution); 32 Loy. L.A. L. Rev. 1273, 1280 (1999) "District courts grant joint inventors an undivided interest in the entire patent although each joint inventor has not contributed proportionally to the invention."

³³ Lemley at 997 (cumulative process of invention and authorship).

³⁴ Most patent improvements relate to technology that substitutes for the original. Most derivative copyrighted works are sold in different markets, are only weak substitutes or are complements. Research tools are the best example of cumulative invention where the downstream outcome serves an unrelated market. Janice M. Mueller, *No "Dilettante Affair": Rethinking the Experimental Use Exception to Patent Infringement for Biomedical Research Tools*, 76 Washington Law Review 1, 2-3(2001) (describing litigation involving a patented enzyme that is necessary for use of polymerase chain reaction (PCR), a fundamental biotech research tool).

³⁵ An earlier copyright owner may claim infringement against a later creator under the reproduction right of Section 106(1) or the adaptation right of Section 106(2). An earlier patent owner may claim infringement for the later creator's use under Section 271(a). My discussion in this section assumes that the later creation falls within the scope of the patent or copyright on the earlier creation. The reverse doctrine of equivalents exempts extreme improvers from patent infringement liability. Lemley at 1010-11. *Westinghouse v. Boyden Power Brake Co.*, 170 U.S. 537 (1898). *Scripps Clinic & Research Foundation v. Genetech, Inc.* 927 F.2d 1565 (Fed. Cir. 1991). And copyright infringement liability can be avoided under the fair use doctrine or if the later creator only takes ideas and not expression from the earlier work. I ignore these possibilities because the first creator is no longer a collaborator — the later creator is free to use the input.

In contrast, the original expressive content of a derivative work of authorship cannot be copyrighted unless the later creator has permission to use the earlier copyrighted work.³⁶

If the later creators fail to get advance permission to use the earlier intellectual property, then they face the risk of an infringement suit.³⁷ A successful plaintiff can recover damages for past infringement. The copyright statute allows the owner of the copyright on the earlier work to recover the portion of the profit from the later work that is attributable to the earlier work. Patent law reaches a similar outcome.³⁸ Plaintiffs cannot recover the defendant's profit but they are entitled to reasonable royalties which are calculated with reference to the defendant's profit among other factors.³⁹ In addition to damages, a successful plaintiff may win an injunction blocking deployment of the later-created intellectual property.⁴⁰ The injunction can be used as a bargaining chip to extract some of the profit derived from the infringing work.

³⁶ Section 103 extends copyright to the original expressive content of a derivative work. *See* Alfred Bell & Co. v. Catalda Fine Arts, 191 F.2d 99 (2nd Cir. 1951). But that section requires permission of the earlier copyright owner. Section 103(a) states that "[t]he subject matter of copyright as specified by section 102 includes compilations and derivative works, but protection for a work employing preexisting material in which copyright subsists does not extend to any part of the work in which such material has been used unlawfully." 17 U.S.C. § 103(a) (1994). *See* Gracen v. Bradford Exch., 698 F.2d 300, 302-03 (7th Cir. 1983).

³⁷ This cumulative creation process falls within my definition of collaboration. Sometimes the original author or inventor consults with the subsequent creator, but I consider the relationship collaborative even when the original creator plays a passive role. I defined collaboration in terms of team production and a thin input market. Both factors are present. Patent or copyright protection assures a thin market for access to the original creation. The team production notion is satisfied because of the difficulty of apportioning the value of the later creation to the effort of the cumulative creator versus the content of the earlier creation. A derivative work like a tee shirt featuring a copyrighted movie character does not fit within the definition of a collaborative work. The owner of the basic copyright faces a thick market for tee shirt manufacturers.

³⁸ The copyright statute allows a copyright owner to recover the larger of compensatory damages or the portion of the infringer's profit attributable to infringement. *See* 17 U.S.C.A. §504. In a case of simple piracy the defendant's profit from infringement is apt to be about the same as the plaintiff's lost profit, and the compensatory and restitutionary damage measure will be equal, but when the infringing work is sold in a new market, then plaintiff's damages are quite distinct from the infringer's profit. *See* Dan B. Dobbs, 2 Law of Remedies 59 (1993). The patent statute specifies damages should be "adequate to compensate for infringement," and at a minimum a patent owner can recover a reasonable royalty. Further, the patent owner can recover lost profits if they are adequately proven. *See* 35 U.S.C.A. §284. The old patent statute allowed recovery of the defendant's profit from infringement. *See* Rev.Stat. §4921, as amended, 42 Stat. 392 (1922). That provision was deleted from the patent statute in 1946, without much explanation. *See* Aro Mfg. v. Convertible Top Replacement Co., 377 U.S. 476 (1964). The infringer's profit still plays a role in the calculation of a reasonable royalty. Since a hypothetical licensee would not pay more than the profit she could derive from a license. *See* Trans-World Mfg. Corp. v. Al Nyman & Sons, Inc., 750 F.2d 1552, 1568 (Fed. Cir. 1984); TWM Mfg. Co., Inc. v. Dura Corp., 789 F.2d 895 (Fed. Cir. 1986).

³⁹ *See* 4 Melville B. Nimmer & David Nimmer, Nimmer on Copyright §14.02[A], at 14-16 (noting copyright cases that apportion profit by using the acquisition cost saved by infringement reach a result similar to patent law's reasonable royalty). Reasonable royalties should be based on a variety of factors including the amount of the defendant's profit attributable to the plaintiff's invention, and the extent to which the invention allowed the defendant to sell related goods. *See* Georgia-Pacific Corp. v. U.S. Plywood Corp., 318 F.Supp. 1116, 1120 (S.D.N.Y. 1970), modified, 446 F.2d 295 (2d Cir.), *cert. denied*, 404 U.S. 870 (1971). *See also* TWM Mfg. Co. v. Dura Corp., 789 F.2d 895 (Fed. Cir. 1986) (allocating a portion of the defendant's anticipated profit to the plaintiff as reasonable royalties); Blair and Cotter.

⁴⁰ A patent is valuable to a cumulative inventor even if his invention is subject to an earlier patent. When the earlier patent expires, the patent on the improvement remains in force and gives the inventor the exclusive right to practice the improvement. Further, the later inventor can block the owner of the earlier

Courts intervene in disputes over surplus division in order to compensate an aggrieved plaintiff and to prevent unjust enrichment. In a case involving cumulative creation of copyrighted works, the Supreme Court embraced the rationale that no collaborator should be unjustly enriched,⁴¹ and it indicated that the purpose of infringement damages is “to provide just compensation for the wrong, not to impose a penalty by giving to the copyright proprietor profits which are not attributable to the infringement.”⁴² Apportionment of the defendant’s profit assures that the defendant is not unfairly penalized and the plaintiff does not reap a windfall.⁴³ The unjust enrichment rationale has also been applied to joint creation cases.⁴⁴ There are a range of theories about how damages should be set to prevent unjust enrichment.⁴⁵ Parts II and III criticize the rationales advanced for the choice of damages in the patent and copyright case law, and provide guidance to courts about how to implement the goal of avoiding unjust enrichment and assuring a fair division.⁴⁶

patent from practicing an improvement. *See* *Marconi Wireless Telegraph Co. v. De Forest Radio Telephone & Telegraph Co.*, 243 F. 560 (2d Cir. 1917); Lemley at 1009. A blocking patent is a valuable bargaining chip when the later inventor is negotiating for a license from the owner of the earlier patent. *Id.* at x.A copyright is less valuable to a cumulative author. The very long life of a copyright means that the later creator might have to wait a long time to enjoy her creation unencumbered by the earlier copyright. A patent term runs twenty years from the date of patent application. A copyright term runs the life of the author plus seventy years. What’s more, a cumulative author cannot get a copyright on a *derivative* work without permission from the owner of the earlier copyright, so the later copyright has *no* value as a bargaining chip. Mark A. Lemley *The Economics Of Improvement In Intellectual Property Law*, 75 *Tex. L. Rev.* 989, 992 (199x) (patent law gives cumulative creators a stronger bargaining position than copyright law). Peter Jaszi, *When Works Collide: Derivative Motion Pictures, Underlying Rights, and the Public Interest*, 28 *UCLA L. Rev.* 715 (1981).

⁴¹ *See* *Sheldon v. MetroGoldwyn Pictures Corp.*, 309 U.S. 390, 399 (1940) (stating the award is designed to “prevent an unjust enrichment.”). *See also* Wendy J. Gordon, *On Owning Information: Intellectual Property and the Restitutionary Impulse*, 78 *Va. L. Rev.* 149, 164, 181-83 (1992) (discussing the role of unjust enrichment and notions of corrective justice in shaping the content of intellectual property law).

⁴² *Sheldon v. MetroGoldwyn Pictures Corp.*, 309 U.S. 390, 399 (1940). *See also* Dane S. Ciolino, *Reconsidering Restitution in Copyright*, 48 *Emory L.J.* 1, 15 (1999) (“The principal rationale for permitting a copyright owner to recover an infringer’s profits is the prevention of unjust enrichment.”).

⁴³ *See* Dan B. Dobbs, *Law of Remedies* x (1993); Douglas Laycock, *Modern American Remedies* 567 (2d ed. 1994). *Data General Corp. v. Grumman Systems Support Corp.*, 36 F.3d 1147, 1175 (1st Cir. 1994). “Moreover, although apportionment primarily depends on questions of causation, it is ultimately a delicate exercise informed by considerations of fairness and public policy, as well as fact.”

⁴⁴ The Federal Circuit rejected a preemption claim and allowed a state law unjust enrichment claim by inventors against a company that applied for a patent on their research without listing them on the patent. *University of Colorado Foundation, Inc. v. American Cyanamid Co.*, 196 F.3d 1366, 1371 (Fed. Cir. 1999), *cert. denied*, 529 U.S. 1130 (2000) (*citing* *DCB Constr. Co. v. Central City Dev. Co.*, 965 P.2d 115, 119-20 (Colo.1998)). “A Colorado unjust enrichment claim requires: (1) at plaintiff’s expense (2) defendant received a benefit (3) under circumstances that would make it unjust for defendant to retain the benefit without paying.” *Id.* The plaintiffs also lodged a fraudulent nondisclosure claim based on the same alleged facts. *Id.*

⁴⁵ HANOCH DAGAN, *UNJUST ENRICHMENT: A STUDY OF PRIVATE LAW AND PUBLIC VALUES* 12-14 1997 (listing five damage measures relevant to unjust enrichment: harm to plaintiff, fair market value, defendant’s revenue, defendant’s profit, or a proportion of defendant’s profit).

⁴⁶ Fair division does not attempt to do justice on a global scale. Unjust enrichment “must presuppose a just baseline of entitlements,” and this baseline must be justified in terms of some outside normative theory. *See* Hanoach Dagan, *Restitutionary Damages for Breach of Contract: An Exercise in Private Law Theory*, 1 *Theoretical Inquiries in Law* 115, 127, 129-30 (2000).

*Thomson v. Larson*⁴⁷ nicely illustrates fair division issues in the copyright context. Larson (and a collaborator who assigned his rights to Larson) created the musical *Rent*. Larson and his producers decided the work needed significant revision and they hired a dramaturg named Thomson. Larson and Thomson revised the musical; critics praised the new version as a radical transformation.⁴⁸ The show was a hit, but Larson died just before it opened. Larson and Thomson had not discussed copyright ownership or how they would divide the authorship royalties from the play. Thomson believed she was entitled to a significant share of those royalties and that Larson would have agreed.⁴⁹ Thomson sought a declaration that she was a co-owner of the copyright and an accounting of the profits.⁵⁰ The court found that Thomson did contribute expressive material to the musical but denied her the status of joint author. The court left unanswered the question of whether Thomson owned a separate copyright on the expressive content that she added, and whether the revised version of *Rent* violated Thomson's copyright.⁵¹ The parties eventually settled and the estate of Larson gave Thomson what she asked for in her original complaint.⁵²

The judicial treatment of the dispute between these collaborators is intriguing because the judge and the parties generally agreed on the facts of the case and shared a rough sense of the fair outcome, but the judge was not able to take control of the problem and implement a fair division of profit. Critics of *Thomson* and similar copyright and patent cases complain that the chief obstacle to implementing a fair outcome is a lack of imagination by the judges. They argue that neither copyright nor patent law erects a barrier to calibrated equitable relief that would fairly divide collaborative profit between the parties.

One apparent barrier to fair division is the rule that joint authors and inventors jointly own their copyright or patent. This barrier is more apparent than real though, since joint ownership does not imply equal ownership rights, and equal sharing is not specified in either the copyright or the patent statutes.⁵³ Regarding copyright law, Dougherty notes that "the rule[] that a coauthor ... is entitled to a pro rata share of proceeds from the work ... arose in the context of songwriting, in which there are usually only two or a few collaborators contributing relatively equal amounts of material."⁵⁴ Nothing in the Copyright Act or property law compels that joint authors as tenants in common hold an equal interest in their copyright — collaborative efforts can be rewarded in accord with

⁴⁷ 147 F.3d 195 (2nd Cir. 1998).

⁴⁸ See *id.* at x.

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⁵⁰ Specifically, Thomson sought 16% of the author's share of the royalties. Her calculation was based on the allegation: "that 48% of the *Rent* script is new in relation to the 1994 Workshop version (prior to her involvement); as co-author, she is, therefore, entitled to 50% of this part (or 24% of the total revenues); but since there are three components to *Rent* (book, lyrics, and music) and she did not contribute to one (music), she is entitled to 2/3, or 16% of the total revenues." 147 F.3d at x.

⁵¹ Thomson did not raise the issue of copyright infringement in the case. *Id.* at x. After the 2nd Circuit decision Thomson filed another case claiming copyright infringement and seeking an injunction against the heirs of Larson. See Dougherty, *supra* note x, at 262.

⁵² *Id.*

⁵³ See F. Jay Dougherty, *Not a Spike Lee Joint? Issues in the Authorship of Motion Pictures Under U.S. Copyright Law*, 49 U.C.L.A. L. REV. 225, 281 (2001) (copyright); x (patent).

⁵⁴ F. Jay Dougherty, *Not a Spike Lee Joint? Issues in the Authorship of Motion Pictures Under U.S. Copyright Law*, 49 U.C.L.A. L. REV. 225, 281 (2001).

each author's contribution.⁵⁵ Similarly, a court is not required to grant *equal* patent ownership rights to every inventor regardless of the nature of each inventor's contribution.⁵⁶

The other apparent barrier to fair division is the widespread use of injunctive relief to remedy copyright and patent infringement. Critics contend that an injunction often over-rewards a plaintiff who can threaten to block the distribution of a collaborative work.⁵⁷ But injunctive relief is subject to the discretion of the judge,⁵⁸ and judges have refused to grant injunctions in some copyright cases in which the plaintiff would be over-rewarded.⁵⁹ Instead the judges have apportioned the defendant's profit between the parties.⁶⁰ Another possibility is to find the plaintiff granted an implied license to the defendant and then calculate appropriate compensation for the plaintiff under the implied license.⁶¹ Several courts and commentators endorse the implied license approach and

⁵⁵ Roberta Rosenthal Kwall, "Author-Stories": Narrative's Implications for Moral Rights and Copyright's Joint Authorship Doctrine, 75 SO. CAL. L. REV. 1, 57-58 (2001).

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⁵⁷ See Roger D. Blair & Thomas F. Cotter, *An Economic Analysis of Damages Rules in Intellectual Property Law*, 39 Wm. & Mary L. Rev. 1585, 1586-88 (1998) (discussing the infringement action in 12 Monkeys); Dane S. Ciolino, *Reconsidering Restitution in Copyright*, 48 Emory L.J. 1, 10 (1999) (noting injunctive relief is routine in copyright cases); Janice M. Mueller, *No "Dilettante Affair": Rethinking the Experimental Use Exception to Patent Infringement for Biomedical Research Tools*, 76 Washington Law Review 1, 58-66(2001) (proposing a liability rule for infringement of biomedical research tools with payments to the patent owner set equal to a reasonable royalty from sale of the end-product, or possibly a legislatively determined royalty rate). The movie 12 Monkeys, infringed the copyrighted drawing entitled *Neomechanical Tower (Upper) Chamber* by the artist Lebbeus Woods. For a discussion of the case and images see Benedict, available at: <http://www.benedict.com/visual/12monkeys/12monkeys.asp> (last visited July 11, 2002).

⁵⁸ A judge has considerable discretion and may grant an injunction "in accordance with the principles of equity to prevent the violation of any right secured by patent, on such terms as the court deems reasonable." 35 U.S.C. § 283 (1988); see also *Ortho Pharmaceutical Corp. v. Smith*, 959 F.2d 936, 945 (Fed. Cir. 1992). Dane S. Ciolino, *Reconsidering Restitution in Copyright*, 48 Emory L.J. 1, 49-52 (1999) (copyright courts have considerable discretion in fashioning injunctions and disgorgement remedies).

⁵⁹ *Abend v. MCA, Inc.*, 863 F.2d 1465, 1478 (9th Cir. 1998). "Defendants invested substantial money, effort, and talent in creating the 'Rear Window' film. Clearly the tremendous success of that venture initially and upon re-release is attributable in significant measure to, inter alia, the outstanding performances of its stars-- Grace Kelly and James Stewart--and the brilliant directing of Alfred Hitchcock. The district court must recognize this contribution in determining Abend's remedy." *Abend v. MCA, Inc.*, 863 F.2d 1465, 1479 (9th Cir. 1998). "The 'Rear Window' film resulted from the collaborative efforts of many talented individuals other than Cornell Woolrich, the author of the underlying story. The success of the movie resulted in large part from factors completely unrelated to the underlying story, 'It Had To Be Murder.' It would cause a great injustice for the owners of the film if the court enjoined them from further exhibition of the movie.... We also note that an injunction could cause public injury by denying the public the opportunity to view a classic film for many years to come." But see Dane S. Ciolino, *Reconsidering Restitution in Copyright*, 48 Emory L.J. 1, 53 (1999) (noting the Lanham explicitly gives judges discretion over recovery of profits in trademark cases but discretion over recovery of profits in copyright cases is less certain).

⁶⁰ See *id.* at x; *Data General Corp. v. Grumman Systems Support Corp.*, 36 F.3d 1147, 1176 (1st Cir. 1994). "*Sheldon* and its progeny suggest that apportionment is almost always available in the context of infringing derivative works, perhaps in part because original expression added by the infringer is itself entitled to copyright protection."

⁶¹ Cohen.

suggest that the implied royalties should be determined in the same fashion as infringement damages.⁶²

II. FAIR DIVISION OF THE PROFIT FROM COLLABORATION

My analysis of fair division derives mostly from economic analysis of fairness. Readers accustomed to moral and political philosophy might be surprised to learn there is a substantial economic theory of fair division.⁶³ To assist such readers let me warn you about what you will and will not find in the following discussion. The analysis is limited to fair division of money among risk neutral collaborators. I treat organizations like firms as individual agents, and I do not distinguish a collaborating firm from a collaborating person. I do not grapple with questions of distributive justice that relate to the wealth or class of the collaborators. I comment on the fairness of entitlements created by intellectual property law, but I avoid some of the difficult issues – like what intellectual property should be privately owned and what should be included in the public domain.

This Part of the Article introduces canonical fair division problems and methods of fair division. My goal is to show that solutions derived from cooperative game theory are plausible, normative appealing, and have some advantages over other solutions to fair division problems. If my argument is effective it will persuade the reader that lessons from cooperative game theory can be used to improve analysis of fair division problems in intellectual property law. Some shortcomings of the proportional method are shown in the context of two party collaboration, but other shortcomings only emerge when there are at least three collaborators. The nucleolus and Shapley value are two (of many) solutions to the fair division problem that are popular in cooperative game theory. These allocation methods overcome some of the criticisms I direct at the proportional method.⁶⁴

⁶² Rochelle Cooper Dreyfuss, Collaborative Research: Conflicts on Authorship, Ownership, and Accountability, 53 VAND. L. REV. 1162, 1223 (1999) (supporting implied copyright licenses with compensation determined in the same fashion as damages are determined in an infringement action) F. Jay Dougherty, *Not a Spike Lee Joint? Issues in the Authorship of Motion Pictures Under U.S. Copyright Law*, 49 U.C.L.A. L. REV. 225, 327-33 (2001) (favoring implied license approach to allocating rights between collaborators); Scott J. Burnham, *The Interstices of Copyright Law and Contract Law: Finding the Terms of an Implied Nonexclusive License in a Failed Work for Hire Agreement*, 46 J. COPYRIGHT SOC'Y U.S.A. 333, 367 (1999) (suggesting that when hired party retains copyright ownership hiring party should have an implied nonexclusive license to use the work); cf. Mark D. Janis, *A Tale of the Apocryphal Axe: Repair, Reconstruction, and the Implied License in Intellectual Property Law*, 58 MD. L. REV. 423 (1999) (discussing implied licensing as the appropriate approach to problems of distinguish repair from infringing reconstruction).

⁶³ For an introduction to cooperative game theory with applications to the law see Michael J. Meurer, Fair Division, 47 BUFF. L. REV. 937 (1999).

⁶⁴ I favor a cooperative game theory *approach* but that does not mean I reject the proportional method as a fair division method. In fact, I prefer proportional sharing in the context of patent and copyright pools. The proportional sharing scheme used by ASCAP and BMI evolved through many formulations shaped to a large degree by antitrust litigation with the government. *United States v. ASCAP*, 1940-1943 Trade Cas. (CCH) P 56,104 at 405 (S.D.N.Y. 1941). *Nimmer on Copyright Section 8.19[A]*. The allocation to members is determined by a formula set forth in the consent decree. Amended consent decree. *United States v. American Society of Composers, Authors and Publishers*, 1950 U.S. Dist. LEXIS 1900; 1950 Trade Cas. (CCH) P62,595 (S.D.N.Y. 1950). “Article XI. Defendant ASCAP is hereby ordered and directed to distribute to its members the monies received by licensing rights of public performance on a basis which gives primary consideration to the performance of the compositions of the members as indicated by objective surveys of performances (excluding those licensed by the member directly)

These methods are also interesting because economists have given them axiomatic characterizations. In other words, each method can be built up from certain axioms about what constitutes fair division.

A. Two-Party Collaboration

Cooperative game theory analyzes fair division in terms of the possible outputs that could be created by the collaborators acting alone or in various combinations. For example, a pair of songwriters can collaborate to write songs, or they can write songs individually. Cooperative game theory is formulated in terms of the value of outputs like songs. Some notions of fairness are formulated instead in terms of the value of inputs like talent or effort. Intellectual property courts faced with fair division problems consider inputs as well as outputs. In cumulative creation cases courts usually apportion a defendant's profit based on output measures, but some courts use input measures instead.⁶⁵ Output measures reveal information about how much value is added to the collaborative product by each contributor.⁶⁶ Courts often state that they seek to award a proportion of defendant's profit to the plaintiff so they can replicate a hypothetical

periodically made by or for ASCAP." *United States v. American Society of Composers, Authors and Publishers*, 32 F.3d 727, 728 (2nd Cir. 1994) "In 1941 the government sued ASCAP under the Sherman Act ... One goal of the government was to insure that the distribution of revenue to ASCAP members be made on a 'fair and non-discriminatory' basis." cite

Merges emphasizes the key role that proportional sharing plays in the stability of ASCAP and other pools.

[T]he proportionality between a member's contribution to the institution and the member's claim on common resources, is at the heart of IPR valuation and royalty splitting within [collective rights organizations]. Ostrom's principle, which calls for proportionality between appropriation and provision rules — essentially, between the amount of the common resource an individual extracts and the amount of labor or money she contributes — is reflected in both ASCAP and patent pools. ASCAP has evolved complex formulas for the division of royalties; so too patent pools, in which royalty splits are determined by contractual provisions and arbitration procedures. Royalties serve the same function as the water allocation rules Ostrom studied: ensuring fair (i.e., proportional) compensation, by calculating royalty splits based on the worth of the patents contributed by each member.

Merges at 1358.

⁶⁵ See generally Dane S. Ciolino, *Reconsidering Restitution in Copyright*, 48 Emory L.J. 1, 20-25 (1999) (describing various methods for apportioning profit in copyright cases). See *Sheldon v. Metro-Goldwyn Pictures*, 309 U.S. 390 (1940). A movie-maker copied from a play. The copyright holder was allowed to recover only the portion of the infringer's profit attributable to the material copied. The court settled on 1/5 of the defendant's profit. The remainder was attributed to factors like acting and directing. The previous patent statute, Rev. Stat. §4921, authorized the recovery of damages and the defendant's profit. *Elizabeth v. Pavement Co.*, 97 U.S. 126, 142 (1877) (the defendant is allowed to offset the award of the defendant's profit by demonstrating the value of an improvement); *Garretson v. Clark*, 111 U.S. 120, 121 (1884); and *Westinghouse Co. v. Wagner Co.*, 225 U.S. 604, 614-15 (1912) (successful plaintiff can recover defendant's profit attributable to plaintiff's patent, but not profit attributable to other patents or improvements). Design patent owners can recover a defendant's profit attributable to infringement. See *Bergstrom v. Sears, Roebuck & Co.*, 496 F.Supp. 476 (1980). Some courts have apportioned profit by finding the ratio of the licensing cost of the infringed work to the total cost of the infringing work. See, e.g., *Estate of Vane v. The Fair, Inc.*, 849 F.2d 186, 189-190 (5th Cir. 1988) (relying on the ratio of fair cost of infringing material to cost of entire infringing work).

⁶⁶ Dan B. Dobbs, 2 *Law of Remedies* 62 (1993) ("The problem of finding net profits is one of accounting; the problem of apportionment is one of tracing the share of profits resulting from infringement.")

bargain between collaborators.⁶⁷ Input measures are not very useful in collaborative settings because individual inputs cannot be measured easily or do not indicate merit reliably.⁶⁸ In many cases there are no contextual clues to determine the appropriate input measure. To be sure, it is also difficult to obtain the required output measures,⁶⁹ because they require probing counterfactual states of the world.⁷⁰ In the leading copyright case, *Sheldon v. MGM*, the court calculated damages by using survey data to estimate the contribution to movie ticket revenue made by various contributors. Movie exhibitors reported that the reputations of actress Joan Crawford and the studio MGM were the main factors determining total receipts, and those receipts still would have been high if the movie plot was written without the benefit of access to the plaintiff's play.⁷¹

In contrast, when courts resolve conflicts over joint authorship and inventorship they exclusively rely on input measures, and they either split the profit equally, or else they give the entire share to one party.⁷² The courts use the input measures to decide whether a relatively minor contributor should get nothing or an equal share.⁷³ The approach in joint creation cases differs from cumulative creation cases because courts (mistakenly) feel blocked by the relevant law from implementing a truly fair division of the profit.⁷⁴ The courts' attention shifts to concern about over-rewarding unimportant or

⁶⁷ See *Georgia-Pacific Corp. v. U.S. Plywood Corp.*, 318 F.Supp. 1116, 1120 (S.D.N.Y. 1970), modified, 446 F.2d 295 (2d Cir.), cert. denied, 404 U.S. 870 (1971) (stating a reasonable patent royalty should be to reflect an amount the parties would have agreed to at the time of infringement). See *infra* x. DONALD S. CHISUM, 7-20 CHISUM ON PATENTS § 20.03 courts rely on a hypothetical negotiation to find "a royalty rate that would divide between them the predicted economic benefits to be realized by the licensor's adoption of the product or process." ("it is usually error to award all of the anticipated profits to the patent owner.") Chisum same page. DAGAN at 19-20 ("*proportional profits* reconstructs the way the parties would have divided the contractual surplus under circumstances of full information (hindsight) and equal bargaining power.") Wendy J. Gordon, *On Owning Information: Intellectual Property and the Restitutionary Impulse*, 78 Va. L. Rev. 149, 190 (1992) ("Plaintiff's entitlements should not extend to all remote benefits for whose existence her actions were a necessary condition-- such an extensive reward hardly would be proportional to the reward deserved.") See *Fromson v. Western Litho Plate & Supply Co.*, 853 F.2d 1568, 1574 (Fed. Cir. 1988) (describing and criticizing the methodology for calculating damages that are calculated to reflect a "hypothetical negotiation[] between [a] willing licensor and willing licensee.") The Federal Circuit directed the district court to calculate damages for fraud and unjust enrichment that reflect the lost payment from hypothetical assignment of the patent. See 196 F.3d at 1373. The effect of this ruling is to give the true inventors the same damage measure they would get in a patent infringement action.

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⁶⁹ An additional complication is determining the movie's profit. The fixed costs of MGM were allocated to the infringing movie and other MGM movies. *Id.* at 52-53. Cooperative game theory is well-suited for analyzing such cost allocation problems.

⁷⁰ See, Laycock, *supra* note x, at 567 ("In theory, the difference between the market value of the play and the profits attributable to the play should be small."); Blair & Cotter, *supra* note x, at 1617 n.141 (noting that the defendant's profit from infringement is the upper bound on a potential licensing fee); Dane S. Ciolino, *Reconsidering Restitution in Copyright*, 48 Emory L.J. 1, 23-24 (1999) (suggesting the fair market value of a license might be the appropriate basis for apportioning the infringer's profit). Courts sometimes rely on fair market value to apportion profit. See *Deltak, Inc. v. Advanced Sys., Inc.*, 767 F.2d 357, 362 (7th Cir. 1985); *Sid & Marty Krofft Television Prods., Inc. v. McDonald's Corp.*, 562 F.2d 1157, 1174 (9th Cir. 1977) (Lost profit can be measured by "what a willing buyer would have been reasonably required to pay to a willing seller for plaintiff[s] work.")

⁷¹ *Id.* at 50.

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opportunistic collaborators. This translates into attention to the intent and behavior of the parties.⁷⁵ The goal of fair division would be better served if the apportionment methods used in cumulative creation cases were applied to joint creation cases. Input measures suffer the same problems in joint creation cases that led courts in cumulative creation cases to focus on output measures.⁷⁶

Rather than contrasting the use of input and output measures, the chief task in this section is to explain how to improve the use of output measures in fair division analysis. To begin, suppose that songwriters Lennon and McCartney collaborate to write songs for an album that is expected to yield a profit of \$4 million. Designate this expected value as $v(L,M) = 4$. Absent collaboration suppose that McCartney expects a profit of \$1.5 million by pursuing his next best opportunity and Lennon expects \$1 million. Let $v(L) = 1$ and $v(M) = 1.5$ represent the *stand-alone* value of profit for Lennon and McCartney. What is a fair division of the \$4 million between Lennon and McCartney?⁷⁷ In this simple problem all of the leading solution concepts⁷⁸ in cooperative game theory select the same division as fair: give 2.25 to McCartney and 1.75 to Lennon. The principle that guides this choice is an equal split of the *gains* from collaboration. Each songwriter gets the sum of his stand-alone profit plus half of the expected gain from collaboration. Lennon gets $1 + .75 = 1.75$, and McCartney gets $1.5 + .75 = 2.25$.

Defense of this allocation as fair requires two steps: an explanation of why each person should be guaranteed their stand-alone value; and an explanation of why the remaining profit should be split equally. A fairness principle called the participation constraint (or individual rationality constraint) states that every player's allocation must equal or exceed what that player could get on his own.⁷⁹ Thus, the constraint requires that Lennon should receive at least 1 and McCartney should receive at least 1.5. If the participation constraint is violated then one of the parties gets less from collaborating than he could get by exiting the collaborative project. But neither party should exit because joint production creates greater surplus. Collaboration makes sense because it yields an expected gain of $1.5 = v(L,M) - [v(L) + v(M)]$. After giving each player his

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⁷⁶ A factor relevant to characterizing a joint work under copyright law is whether "the audience appeal of the work turns on both contributions and 'the share of each in its success cannot be appraised.'" *Aalmuhammed v. Lee*, 202 F.3d 1227, 1234 (9th Cir. 2000). Notice that this is the definition of team play that figures in my definition of collaboration. Learned Hand also noted that in movie collaboration you really cannot identify who *causes* each unit of collaborative profit. *Shelden* at x. The gain is jointly created. Suppose, instead, the team production condition is not satisfied and collaborative profit can be decomposed and attributed to particular members. If so, then the parties are apt to apportion the profit accordingly. A cooperative project that lacks positive interactions between players fails my definition of collaboration. A collective work like an encyclopedia is not collaborative. The payoff structure is additive and the proportional rule, the Shapley value, and nucleolus coincide. Suppose A, B, and C all write articles for the encyclopedia. Then the coalition values are given by: $v(A) = 3$, $v(B) = 2$, $v(C) = 1$, $v(A,B) = 5$, $v(A,C) = 4$, $v(B,C) = 3$, and $v(A,B,C) = 6$. The fair outcome is simply the stand-alone values of 3 for A, 2 for B, and 1 for C.

⁷⁷ In the jargon of cooperative game theory, the singletons $\{L\}$, $\{M\}$, and the pair $\{L, M\}$ are called coalitions. A cooperative game consists of the list of coalitions and the payoff available to each coalition. A solution of a cooperative game is an allocation of the total feasible payoff among the players in the game. One goal of cooperative game theory is to justify a particular solution as fair.

⁷⁸ The Nash bargaining solution, the Shapley value and the nucleolus all give the same result.

⁷⁹ By assuring that each collaborator receives at least his stand-alone value courts protect each collaborator's well being. Dagan.

stand-alone value there is still \$1.5 million to divide.⁸⁰ An equal split of the collaborative gain can be justified as intrinsically fair since there is no moral argument for distinguishing the parties, or justified on the grounds that it reflects the expected bargaining outcome of two equally skilled bargainers.

Of course, a consensus within cooperative game theory about what is fair does not suggest any general consensus about a fair solution to this problem. Even if we ignore the intentions of the parties, and suppose that Lennon and McCartney are in morally equivalent situations outside the bounds of this problem, there are still a range of defensible solutions. The proportionality principle can be used to find a solution based on some measure of the merit of the two parties. Merit could be measure in terms of inputs like effort and talent,⁸¹ or in terms of output like stand-alone profit,⁸² or some combination of measures.⁸³ For example, one can argue it is fair to reward the parties in proportion to their stand-alone profit. Lennon would be entitled to forty percent of the profit,⁸⁴ thus Lennon gets 1.6 and McCartney gets 2.4. Alternatively, one can argue it is fair to split the profit equally because they worked equally hard (assuming they did).

Both an equal split and proportional sharing appear reasonable in this problem, but are less appealing when we consider a family of related problems. Table One presents four related problems of fair division including the one described above. The four problems all require the division of 4 units of profit between Lennon and McCartney. The problems differ in terms of the stand-alone values. In each problem the equal sharing solution is the same: 2 for each. Similarly, the proportional solution is the same in each problem: 1.6 for Lennon and 2.4 for McCartney.⁸⁵ Notice that the cooperative game theory solution moves from the egalitarian solution to the proportional solution as the stand-alone values rise.

Collaborative Profit	4	4	4	4
Gain from Collaboration	4	3.75	1.5	0
v(L)	0	0.1	1.0	1.6
v(M)	0	0.15	1.5	2.4
Payoff to Lennon	2	1.975	1.75	1.6

⁸⁰ I have implicitly assumed that collaboration only occurs when agents gain some advantage from cooperation. Notice what happens to the fair division problem when there are no gains from cooperation. Suppose that Lennon and McCartney have the same outside opportunities: $v(L) = 1$ and $v(M) = 1.5$. But now assume that there are no gains from cooperation, so that their joint payoff is just the sum of their individual payoffs: $v(L,M) = 2.5$, instead of 4. The only division of surplus that is compatible with the participation constraint gives 1 to Lennon and 1.5 to McCartney.

⁸¹ One input measure used in a copyright case is the proportion of the defendant's content that is infringing. See *Frank Music Corp. v. Metro-Goldwyn-Mayer, Inc.*, 886 F.2d 1545, 1548 (9th Cir. 1989).

⁸² See *Sheldon v. Metro-Goldwyn Pictures Corporation* 106 F.2d 45, 48 (2nd Cir. 1939), *aff'd* 309 U.S. 390 (1940). Judge Learned Hand was not satisfied with this approach and lamented: "Strictly and literally, it is true that the problem is insoluble." *Id.*

⁸³ Profit can also be divided in proportion to claims. Suppose two software collaborators worked for a client who went bankrupt. If the client promised each programmer a separate and distinct fee, then the estate could be apportioned according to the ratio of the fees.

⁸⁴ That percentage is derived by dividing Lennon's stand-alone value by the sum of the stand-alone values, $1/(1+1.5) = (2/5)$, or forty percent.

⁸⁵ Ignoring the problem that the proportional solution is not defined when the stand-alone values are both zero.

Payoff to McCartney	2	2.025	2.25	2.4
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Table One

The results in the table suggest that proportional sharing is unfair when the stand-alone values that are used to measure merit are relatively small, and the gain from collaboration is relatively large. There is no good reason that McCartney should get a much bigger payoff than Lennon when McCartney's stand-alone payoff is 0.15 and Lennon's is 0.1. The difference between these values is relevant and reflected in the cooperative solution, but the ratio of the stand-alone values should not be allowed to have so much influence over the allocation of profit. Conversely, the proportional method approximates the cooperative game theory solution if the gains from collaboration are small — both methods seem fair. Equal sharing appears less fair when the gains from collaboration are small. When McCartney's stand-alone value is 2.4 (or any value greater than 2), equal sharing violates the participation constraint. By contrast, the proportional rule always satisfies the participation constraint.⁸⁶

Separability is an appealing property for fair division methods, it requires: changes in payoffs that are not related to collaboration should not affect the division of the profit from collaboration. The Shapley value and nucleolus both satisfy this principle, but proportional and equal sharing do not. Consider a fair division problem in which Lennon and McCartney can collaborate to create 3 units of profit or they can each get 1 unit of profit on their own: $v(L) = v(M) = 1$, $v(L, M) = 3$. All methods under consideration give a payoff of 1.5 to each party. Now suppose McCartney contributes one more unit of value regardless of whether collaboration occurs, so $v(L) = 1$, $v(M) = 2$, $v(L, M) = 4$. Imagine this change occurs because McCartney writes some songs on his own that are packaged with the collaborative songs. The new cooperative solution yields the intuitive result — Lennon gets the same payoff of 1.5, and McCartney's payoff grows by one unit of profit to 2.5. The proportional rule reduces Lennon's payoff to $4/3$, and increases McCartney's payoff above 2.5 to $8/3$. The reduction of Lennon's payoff seems unfair because he still brings the same value to the collaboration. Equal sharing creates the opposite problem, McCartney's payoff grows by less than 1, thus he fails to capture the full value of his separate songs.⁸⁷

B. *Three-Party Collaboration*

Three-party collaboration introduces important fair division issues not present in two-party collaboration. Suppose that Archimedes, Bell, and Colt collaborate on an invention. Let the expected value of their project be given by $v(A,B,C) = 9$. Suppose that any of these inventors acting alone could earn an expected value of 2, or $v(A) = 2$, $v(B) = 2$, and $v(C) = 2$. The new feature of the three-party problem is the possibility that some group of two might break off and form their own collaborative project. I recognize this possibility by listing the expected value of each of these possible two person teams.

⁸⁶ If proportionality is implemented using input measures, the resulting allocation of surplus might not satisfy the individual rationality constraint.

⁸⁷ If motives are relevant to fair division, then we might not be troubled by this outcome. If McCartney intended to be generous to Lennon by incorporating the separable value into the collaborative output, then the egalitarian outcome is fair.

Assume that Archimedes paired with either Bell or Colt would create an expected value of 5 for the pair, and assume that Bell and Colt would create an expected value of 6.5, i.e., $v(A,B) = 5$, $v(A,C) = 5$, and $v(B,C) = 6.5$. The various coalition values are collected in Table Two. To find the proportional sharing outcome note that each party's stand-alone value is 2, so each party should get an equal share of 3.

$v(A) = 2$	$v(B) = 2$	$v(C) = 2$
$v(A,B) = 5$	$v(A,C) = 5$	$v(B,C) = 6.5$
	$v(A,B,C) = 9$	

Table Two

Proportional sharing is a troubling solution to this problem. Notice that Bell and Colt are likely to object to this allocation. If they forced Archimedes out of the all-inclusive team and worked as a pair they could collect an expected payoff of 6.5 compared to the sum 6 that they receive jointly under proportional sharing. The proportional method is troubling because it does not take account of the information concerning the two-party coalitions. A surplus division is more attractive if it is resistant to defection by some unhappy coalition. In the language of game theory we can ask that a solution satisfy a *group rationality* constraint. Group rationality generalizes individual rationality. Group rationality is satisfied if every coalition of players gets at least as much from three person collaboration as it could get by defecting from all-inclusive collaboration and setting up a smaller team (of either one or two). Defection because of unfairness is a serious problem for patent and copyright owners who collaborate to enforce their intellectual property rights. After providing some background information, I will illustrate the importance of the group rationality constraint by describing the formation of Broadcast Music, Inc. (BMI).

Collaborative enforcement is common in both patent and copyright protected industries. There are several examples of industries forming patent pools in response to a flood of patents in the industry.⁸⁸ On the copyright side, music performance licenses and journal photocopying licenses are managed by collective rights organizations. Collaborative enforcement is valuable because it reduces enforcement and transaction costs.⁸⁹ Pools collect licensing fees and distribute the revenue to members. Usually the pools issue blanket licenses that cover all of the patents or copyrights in the pool.⁹⁰ The revenue is allocated in proportion to the value of the patents or copyrights that each member has placed in the pool.⁹¹ As one might expect valuing members' patents or copyrights is not easy.⁹²

⁸⁸

⁸⁹ This rationale was powerful enough to negate liability for price fixing under the Sherman Act. See *Broadcast Music, Inc. v. C.B.S.*, x U.S. x (19xx).

⁹⁰ BMI or ASCAP issue blanket licenses. See MICHAEL FINK, *MUSIC IN CONTEMPORARY LIFE* 53 (Schirmer Books 1989). The most important licenses are issued to radio and TV networks and stations. Local stations pay one percent of a station's gross income to ASCAP. Networks usually pay a flat fee of several million dollars. *Id.*

⁹¹ See *Standard Oil Co. v. United States*, 283 U.S. 163, 171 (1931) (revenue from patent pool distributed according to value of patents held by a member); *United States v. American Society Of Composers, Authors and Publishers*, 32 F.3d 727, 729 (2nd Cir. 1994) ("ASCAP's by-laws, the consent decree continues, shall provide that money received for public performance for profit of the members' copyrighted

The two largest music performance rights organizations in the United States are the American Society of Composers, Authors, and Publishers (ASCAP) and BMI. They each control performance rights to millions of songs. ASCAP and BMI estimate the performance value of a copyrighted musical composition by monitoring public music performances and using that information to estimate licensing revenue attributable to a composition.⁹³ They monitor performances by requiring broadcasters to keep performance logs,⁹⁴ and they survey other public performance venues.⁹⁵ ASCAP has a system of performance credits that depends on duration (e.g., full length or excerpt); the use (e.g., feature or background); source (TV, radio, etc.); and the time of day.⁹⁶ The performance credits determine a member's royalty.⁹⁷ The formula for specifying credits continues to create disputes about fairness.⁹⁸

Members jockeying for a greater share of the licensing revenue may threaten the stability of a pool.⁹⁹ The stability of a pool might be disrupted by exit, by creation of a competing pool, or by private antitrust suit.¹⁰⁰ The threat is greater when some members feel the sharing rule is unfair to them.¹⁰¹ Most pools use some kind of weighted voting to select leadership; the weighting is based on the same kind of factors that determine royalty shares.¹⁰² In an antitrust suit against ASCAP, the government complained that

musical compositions shall not be distributed on any basis other than 'the number, nature, character and prestige' of the members' compositions, how long the works have been part of the Society's catalog, 'and popularity and vogue of such works, all to be determined in a fair and non-discriminatory manner.'")

⁹² Valuation disputes led to antitrust litigation between the government and ASCAP. *United States v. ASCAP*, 1940-1943 Trade Cas. (CCH) P 56,104 at 405 (S.D.N.Y. 1941).

⁹³ *Merges* at 1329. "[ASCAP] monitors the songs played and divides up the total receipts among all members on the basis of a complex pro rata formula." *Id.* at 1335 "As ASCAP has grown, it has devised ever more sophisticated techniques for determining ... a fair division of royalty income among members."

⁹⁴ See *Merges* at 1335; SIDNEY SHEMEL & M. WILLIAM KRASILOVSKY, *THIS BUSINESS OF MUSIC* 200-1 (1990). Program logs are verified by comparing them to tapes of programs. ASCAP and BMI apply sampling to most local radio station and local television performances. *Id.* ASCAP also uses tapes of about 10,000 hours of local television performances. BMI requires its broadcast licensees to supply a station-prepared log of music used in a particular period. *Id.* at 201.

⁹⁵ *United States v. American Society of Composers, Authors and Publishers*, 1960 U.S. Dist. LEXIS 4967; 1960 Trade Cas. (CCH) P69,612 (S.D.N.Y. 1960). (requiring a more accurate survey design that increased sampling of local radio, nightclubs, and Muzak).

⁹⁶ <http://www.ascap.com/membership/dollars.html>. Visited August 5, 2000. Frequently performed songs get a premium. *Id.*

⁹⁷ *Id.*

⁹⁸ A composer of jingles complained that his royalty was too low because jingles did not get adequate performance credits. See *United States v. American Society Of Composers, Authors and Publishers*, 32 F.3d 727 (2nd Cir. 1994). "In 1981 as a result of Karmen's and other jingle writers' efforts, ASCAP raised the weight accorded jingles from one percent to three percent of a 'use credit'" *Id.* at 728. *But see Merges* at 1338 (ASCAP's members are generally satisfied with the division royalties).

⁹⁹ *Merges* at 1352. Pool members act strategically to maximize their share of the surplus.

¹⁰⁰ *Merges* at 1355 Patent pool members can use the threat of an antitrust suit to destabilize the pool.

¹⁰¹ Zajac; Fehr. *Merges* at 1338 ("...members acquiesce in the compensation schemes of these societies, despite the fact that there are numerous points for possible disputes, because they realize that without joint action no compensation would be forthcoming at all.")

¹⁰² Robert P. Merges, *Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations*, 84 Cal. L. Rev. 1293 (1996). note 150 ASCAP relies on voting that is weighted by the value of members' copyrights. *Merges* at note 182 The airplane patent pool used voting weighted by the value of members' patents.

established music publishers controlled ASCAP to the detriment on newcomers,¹⁰³ and the consent decree changed the voting weights to reduce the power of those currently in control.¹⁰⁴

The establishment of BMI by defectors from ASCAP presents dramatic evidence of the failure of the original ASCAP sharing rules to satisfy the group rationality constraint. There are two stories explaining the establishment of BMI. They are consistent and probably both correct. The first story tells us that radio broadcasters rebelled against ASCAP to fight the monopoly prices for performance licenses.¹⁰⁵ The very name Broadcast Music, Inc. reflects the role of broadcasters in organizing the competing pool.¹⁰⁶ The second story tells us that composers from the Tin Pan Alley tradition and music publishers controlled by the movie studios dominated ASCAP.¹⁰⁷ This dominant group discriminated against composers representing alternative music genres such as jazz, blues, and country.¹⁰⁸ The broadcasters had the resources and credibility to set up a competing music performance rights pool, and the disaffected composers and publishers provided the compositions.¹⁰⁹ The emergence of BMI is

¹⁰³ United States v. American Society of Composers, Authors and Publishers, 1960 U.S. Dist. LEXIS 4967; 1960 Trade Cas. (CCH) P69,612 (S.D.N.Y. 1960). (changes were made to treat young writers more fairly) ASCAP also had restrictive membership rules that required a writer to have published five hit songs to gain admission. Paul Kingsbury, *A Creative Alternative* (visited June 6, 2000) <<http://www.bmi.com/about/library/history/creative.asp>>.

¹⁰⁴ Amended consent decree. United States v. American Society of Composers, Authors and Publishers, 1950 U.S. Dist. LEXIS 1900; 1950 Trade Cas. (CCH) P62,595 (S.D.N.Y. 1950). Article XIII Revised election of Board of Directors “[i]n order to insure a democratic administration of the affairs of defendant ASCAP...” United States v. American Society of Composers, Authors and Publishers, 1960 U.S. Dist. LEXIS 4967; 1960 Trade Cas. (CCH) P69,612 (S.D.N.Y. 1960). (changed weighting of votes to reduce power of those currently in control).

¹⁰⁵ Merges at 1335. “ASCAP’s chief competition, BMI, was founded in 1940 by radio stations trying to obtain some leverage against ASCAP. The creation of BMI followed a number of failed attempts to limit ASCAP’s effectiveness through legislation.” Radio broadcasters effectively boycotted ASCAP in 1940. In March of 1940, ASCAP’s proposed a 100 percent increase in radio’s rates over the previous year. That came after a rate increase between 1931 and 1939 of 448 percent. Paul Kingsbury, *A Creative Alternative* (visited June 6, 2000) <<http://www.bmi.com/about/library/history/creative.asp>>.

¹⁰⁶ In 1939, National Association of Broadcasters (NAB), formed the Broadcast Music, Inc. (BMI). MICHAEL FINK, *MUSIC IN CONTEMPORARY LIFE* 131 (Schirmer Books 1989).

¹⁰⁷ Paul Kingsbury, *A Creative Alternative* (visited June 6, 2000) <<http://www.bmi.com/about/library/history/creative.asp>> (movie studios dominated publishers).

¹⁰⁸ Country stars such as Gene Autry and jazz greats like Jelly Roll Morton were rejected for years by ASCAP before finally gaining membership. Paul Kingsbury, *A Creative Alternative* (visited June 6, 2000) <<http://www.bmi.com/about/library/history/creative.asp>>. John Ryan, *The Production of Culture in the Music Industry: The ASCAP-BMI Controversy* 61-64 (1985) (jazz great Jelly Roll Morton and country music great Gene Autry had trouble gaining access to ASCAP and collecting performance royalties) 65-70 (discrimination against “race” and “hillbilly” music composers by ASCAP)

¹⁰⁹ BMI sought to attract smaller publishers and newer songwriters who had been excluded by ASCAP and tried to improve methods of surveying music performances. MICHAEL FINK, *MUSIC IN CONTEMPORARY LIFE* 131 (Schirmer Books 1989). Ryan 109-112 (BMI paid royalties based on live and recorded performances on network and independent radio. ASCAP only paid royalties on live performances over network radio. The royalty structure and other policies of BMI favored jazz and country music composers)

surprising given the high cost of duplicating ASCAP's administrative structure, and shows the degree of unfairness that must have existed in the original sharing rules.¹¹⁰

A proportional sharing scheme is vulnerable to the risk of defection, but for many problems proportional schemes can be designed that are resistant to defection. The relative stability of ASCAP and BMI since the 1940s suggests the problem is manageable. The competition between the pools and threatened and actual government oversight help assure that all composers are relatively satisfied with the allocation of licensing revenue.

A different weakness of proportional sharing arises from its failure to recognize positive externalities created by a player's membership in a team. Proportional sharing recognizes individual merit as measured by stand-alone payoffs, but it does not recognize merit in the form of *team play*. A desirable sharing method should reward both individual talent, and also a talent for bringing the best out of one's collaborators. Consider the example displayed in Table Three. Assume that all three players have the same stand-alone payoff: thus, $v(A) = v(B) = v(C) = 1$. Further assume that when Archimedes and Bell form a team they just get the sum of their stand-alone payoffs, but when Colt joins either of the other two he creates a favorable interaction that raises the expected joint payoff to 3: $v(A,B) = 2$, and $v(A,C) = v(B,C) = 3$. Finally, assume that when all three collaborate the payoff is $v(A,B,C) = 4$. Obviously, proportional sharing gives all three players the same payoff of $(4/3)$. Something more should be given to Colt if we want to make the solution consistent with the team play principle. Table Three lists two alternative solutions that I explain in the next section. Both alternatives satisfy the team play principle.

$v(A) = 1$ $v(A,B) = 2$	$v(B) = 1$ $v(A,C) = 3$ $v(A,B,C) = 4$	$v(C) = 1$ $v(B,C) = 3$	
	A	B	C
Proportional	4/3	4/3	4/3
Nucleolus	1	1	2
Shapley value	7/6	7/6	5/3

Table Three

C. Cooperative Game Theory — The Shapley Value and the Nucleolus

Two solution concepts that are popular in cooperative game theory can overcome some of the problems I attribute to the proportional sharing method. A key difference is the game theoretic concepts use information about every possible coalition not just the

¹¹⁰ Merges at ?. Pools may involve large set-up costs. "These costs result from (1) differing assessments of the technological merits of the contributions by the members of the pool, (2) private information held by each member concerning the precise characteristics of the technology and the details of the patent position (all relevant prior art, etc.), and (3) strategic bargaining possibilities created by the negotiations over the potentially large "pooling surplus" that may result from the creation of the pool." Ryan at 79 (in the 1930s some large publishers fought with ASCAP over royalty division and threatened to secede) 84 (In 1940 BMI lured one major music publisher away from ASCAP)

stand-alone coalitions. The solution concept called the *Shapley value* assigns the surplus division that gives every player his or her average marginal contribution to the collaborative enterprise. The solution concept called the *nucleolus* assigns the surplus division that maximizes the satisfaction of the least satisfied coalition of players.¹¹¹ Let me explain the solution concepts more carefully and illustrate them with some examples.¹¹²

To find the Shapley value solution of the problem presented in Table Three, start with the payoff to Archimedes. First, identify his marginal contribution to each coalition. Potentially, he makes a contribution to the following coalitions: $\{A\}$, $\{A, B\}$, $\{A, C\}$, and $\{A, B, C\}$. To find his marginal contribution simply find the difference between the value to a coalition with and without Archimedes, i.e., $v(A,B,C) - v(B,C) = 1$, $v(A,B) - v(B) = 1$, $v(A,C) - v(C) = 2$, and $v(A) - v(\emptyset) = 1$. Second average these marginal contributions to determine his payoff. The reader might expect to weight each marginal contribution by one-quarter to calculate the average marginal contribution; that is not quite the correct. Instead, weight the marginal contributions to $\{A\}$, and $\{A, B, C\}$ by one-third and the marginal contributions to $\{A, B\}$ and $\{A, C\}$ by one-sixth. The result is a Shapley value payoff of $1(1/6)$ for Archimedes. The explanation of the weighting comes from the following heuristic. Imagine that coalitions are formed as A, B, and C randomly arrive at a meeting room. There are six possible orderings: (A, B, C); (A, C, B); (B, A, C); (C, A, B); (B, C, A); and (C, B, A). Each has a probability of one-sixth. The probability that A arrives second after B is one-sixth, and the probability that A arrives second after C is one-sixth. These probabilities are used as the weighting on the marginal contribution to the coalitions $\{A, B\}$ and $\{A, C\}$. The probability that A arrives last is one third, so the weight on the marginal contribution to the coalition $\{A, B, C\}$ is one-third. The probability that A arrives first is one third, so the weight on the coalition $\{A\}$ is one-third. Since Bell's role in the problem is symmetric to Archimedes's role his payoff is the same. Colt takes the rest of the surplus and gets a payoff of $1(2/3)$.

The nucleolus maximizes the satisfaction of the least satisfied coalition that could form from the trio of Archimedes, Bell, and Colt. Satisfaction is measured as the difference between the total payoff to coalition members minus the amount they could get by defecting. Compared to the Shapley value, the nucleolus for this game shifts surplus from Archimedes and Bell to Colt. It assigns a payoff of 1 to both Archimedes and Bell, and a payoff of 2 to Colt. This allocation gives Archimedes and Bell both zero satisfaction, i.e., a payoff equal to their stand-alone values, and Colt gets more than his stand-alone value. The pair of Archimedes and Bell also gets zero satisfaction because their combined nucleolus payoffs equal the coalition's value from defection, i.e., $1 + 1 =$

¹¹¹ More precisely, the nucleolus calls for a lexicographic maximization. After the least satisfied coalition is made as well off as possible, then the second least satisfied coalition is made as well off as possible, etc.

¹¹² Though obscure, both solution concepts have been applied to real-life fair division problems. The nucleolus appears in several Talmudic writings that apply the procedure to estate division and partnership dissolution problems. See YOUNG, *supra* note 12, at 71. Civil engineers developed a scheme to allocate dam construction costs that is similar to the Shapley value. See *id.*, *supra* note 12, at 86. And more surprising, colluding bidders at used machinery auctions used the Shapley value to divide the spoils from their collusion. See Daniel Graham, Robert C. Marshall, & Jean-Francois Richard, *Differential Payments within a Bidder Coalition and the Shapley Value*, 80 AMER. ECON. REV. 493 (1990). The bidders involved in the collusive ring were ultimately detected and prosecuted. See *U.S. v. Seville Industr. Mach. Corp.*, 696 F. Supp. 986 (D. N. J. 1988).

$v(A,B) = 2$. Likewise, the other two pairs just get a joint allocation that equals the payoff they could get on their own, namely, $1 + 2 = v(A,C) = v(B,C) = 3$. The least satisfied coalitions all get a satisfaction level of zero. That is the maximum possible. In contrast, the least satisfied coalitions under the Shapley value get a satisfaction level of $-(1/6)$. The pair of Archimedes and Colt (and Bell and Colt) gets a total payoff of $1(1/6) + 1(2/3)$ which is $1/6$ less than $v(A,C) = 3$.

Now let's compare the performance of the nucleolus and Shapley value to the proportional rule in terms of the group rationality and team player issues. I criticized the proportional rule because it did not recognize that Colt is a team player, and because it violated group rationality. The two cooperative game theory solution concepts both respect the principle that Colt should be rewarded for team play. But in this example the nucleolus but not the Shapley value satisfies group rationality. The Shapley value gives Colt more than Bell or Archimedes, thus rewarding him for team play, but it is susceptible to defection by either the pair of Colt and Bell, or the pair of Colt and Archimedes. Defection would give either pair a payoff of 3, compared to the payoff of $1(1/6) + 1(2/3)$ that they receive under the Shapley value allocation. The nucleolus gives Colt a little bit more — enough so that the temptation for defection just disappears. Either pair gets a combined payoff of $1 + 2$ from the nucleolus.

The group rationality principle turns out to be very demanding. There are many fair division problems such that no payoff allocation satisfies group rationality.¹¹³ In the preceding example, the nucleolus is the unique allocation satisfying group rationality. (The reader can check that assertion by noting that a payoff to Colt larger than 2 implies that either Archimedes or Bell gets a payoff less than 1 and has an incentive to defect.) The construction of the nucleolus guarantees that it satisfies group rationality whenever it is possible to satisfy group rationality. The team play principle is not so demanding. It is always satisfied by the Shapley value and the nucleolus.

Summary. The Shapley value, the nucleolus, and proportional sharing satisfy the participation constraint; they yield allocations that give a person at least as much as he could get on his own. The Shapley value and the nucleolus, but not proportional sharing, satisfy the team play principle and separability. Proportional sharing violates separability by making allocations sensitive to factors outside the scope of collaboration. It violates the team play principle because it is constructed to respond only to individualized measures of merit. Nucleolus is most likely to satisfy group rationality, but there are fair division problems for which no solution can satisfy that requirement.

D. *An Axiomatic Basis for the Shapley Value and the Nucleolus*

Solution concepts can be evaluated in terms of fairness principles, or by comparing the axioms that constitute the solution concept. This presents an informal description of the axiomatic basis of the Shapley value and nucleolus. In the next section I evaluate the appropriateness of the axioms in the context of joint creation, cumulative creation, and joint administration of intellectual property. I conclude that the nucleolus points toward a patent and copyright policy that favors creators with a strong market position because they are essential collaborators like employers (relative to employees)

¹¹³ In other words, the *core* does not exist for many cooperative games. An allocation is in the core if it satisfies the group rationality principle.

and early creators (relative to later creators). The Shapley value leads to a more egalitarian solution in the markets discussed below. It points toward profit sharing with inessential collaborators.

An axiomatic analysis requires that game theorists specify a list of axioms (desirable properties) that a fair solution should satisfy and then check to see which feasible allocations satisfy every axiom in the list. It is possible to develop a list of axioms that produces one and only one “fair” division for every cooperative game.

A rough version of the axiomatic characterization of the Shapley value states: it is the unique allocation rule that is (i) impartial, (ii) Pareto optimal, and (iii) satisfies the marginality principle. Impartiality means that the allocation only depends on the relevant specified information. The allocation cannot depend on factors that are morally arbitrary – like whose name is shorter. Pareto optimality simply means that all benefits are allocated; nothing is wasted. In the cost allocation context, Pareto optimality means that the sum of the allocated costs equals and does not exceed the required cost of the project. The marginality principle requires that a player’s allocation depends only on that player’s marginal contributions to all possible coalitions.

A rough version of the axiomatic characterization of the nucleolus states: it is the unique allocation rule that is (i) impartial, (ii) Pareto optimal, (iii) homogeneous, (iv) separable, and (v) satisfies the consistency principle. The first two axioms also appear in the characterization of the Shapley value. The marginality principle in the Shapley value characterization is replaced in the nucleolus characterization by homogeneity, separability, and consistency. Costs or benefits are separable if they are solely attributable to one player. A solution concept satisfies separability if it allocates the separable portion of cost or benefit to the responsible party. A solution concept is homogeneous when scaling up costs or benefits scales the allocation in the same way. Roughly speaking, a solution concept is consistent if it gives the same allocation over a group of players when the number of players in the game is scaled up or down in a regular way.¹¹⁴

A policy analyst who prefers the Shapley value to the nucleolus must have some reason for preferring the marginality principle to the consistency principle. Conversely, an analyst who prefers the nucleolus must also prefer the consistency principle. These are the two axioms that clash.¹¹⁵ Therefore, we need to explore the meaning of these two axioms.

The example displayed in Table Four is derived from the example in Table Three and demonstrates the nucleolus may violate the marginality principle. Recall the example in Table Three is structured so that Colt is a team player and gets a higher payoff on account of the positive externalities that he generates. The values in Table Three are reproduced below. The new information in brackets in Table Four relates to a modified game. I modified the game in such a way that Colt’s marginal contributions are unchanged. Specifically, $v(A)$ falls from 1 to 0, and $v(A,C)$ falls from 3 to 2. Notice that $v(A,C) - v(A)$ is equal to 2 in both games, so that the marginal contribution by Colt to the coalition $\{A,C\}$ is the same in both games. Colt’s marginal contributions to other coalitions are unaffected. The “old” nucleolus and Shapley value are the values derived

¹¹⁴ Michael J. Meurer, *Fair Division*, 47 *Buff. L. Rev.* 937, 959-961 (1999).

¹¹⁵ The Shapley value satisfies the separability and homogeneity axioms. They are not listed as Shapley value axioms because they are redundant, i.e., the Shapley value can be characterized without them.

for the problem in Table Three; the new values in brackets are for the modified game. As required by the marginality principle, the Shapley value payoff to Colt is the same in both games. Under the nucleolus, the payoff to Colt declines in the new game. Intuitively, Colt was an essential team player in the original game, but in the new game Bell is just as valuable as a team player. The nucleolus provided a “bonus” to Colt’s payoff in the original game in recognition of his indispensable status. In the new game that “bonus” disappeared along with his special status.

$v(A) = 1$ [0] $v(A,B) = 2$	$v(B) = 1$ $v(A,C) = 3$ [2] $v(A,B,C) = 4$	$v(C) = 1$ $v(B,C) = 3$	
	A	B	C
Old Nucleolus	1	1	2
New Nucleolus	[1/2]	[7/4]	[7/4]
Old Shapley value	7/6	7/6	5/3
New Shapley value	[2/3]	[5/3]	[5/3]

Table Four

Now let me elaborate on the consistency principle. Suppose that two recording companies successfully sue a music pirate for copyright infringement. Company A wins a judgment for \$10 million and company B wins a judgment for \$20 million. Suppose the pirate’s assets of \$25 million are not sufficient to cover both claims. We could use either the nucleolus or the Shapley value to decide how much to award each of the plaintiffs. The nucleolus has the following attractive property: the allocation does not change when the game is scaled up by “cloning” A and B in a certain way. Specifically, consider a new problem in which companies A and A’ both have a claim to \$10 million and companies B and B’ both have a claim to \$20 million and the defendant’s assets are doubled to \$50 million. In both problems the nucleolus gives \$7.5 million to A and \$17.5 million to B. When there are only two claimants the Shapley value gives the same result as the nucleolus. But when there are four claimants, the Shapley value raises the allocation to A and cuts the allocation to B. The nucleolus remains invariant as more cloned A’s and B’s are added to the game. This invariance is attributable to the consistency principle.

My last task in this section is to link the marginality and consistency axioms to the fairness principles discussed in the previous sections. The relationship between the consistency axiom and the nucleolus parallels the relationship between the core and a competitive economy. The core is defined as the set of allocations in a game that satisfies the group rationality constraint. Microeconomic theorists have explored the link between bargaining and competition. They have shown that when you take a game with two bargainers (like A and B in the previous paragraph) and clone them repeatedly (as in the previous paragraph) the core of the sequence of games converges to the competitive outcome. The consistency principle serves to promote the values of competition and market autonomy in the non-competitive market environments that I consider. The consistency principle assures that the nucleolus always satisfies the group rationality condition (and so lies within the core) whenever that is possible. Thus the consistency

principle is morally attractive to the extent that one values group rationality. An independent reason to favor the consistency principle arises in the context of joint enforcement. The copyright and patent pools that I describe below have open membership that changes over time. The consistency principle assures that members are treated consistently as membership grows or declines in a regular way.

The marginality principle finds justification in the same kinds of arguments that justify the proportionality principle. It adapts the proportionality principle to a context where it is difficult to judge individual merit based on individual contribution (and where there is no obvious intrinsic difference in individual merit). The marginality principle implements an allocation that responds to merit measured by what a collaborator brings to feasible coalitions. An interesting implication of this principle is that when a windfall befalls a collaborative venture the collaborators always share the windfall. The Shapley value spreads out the benefit from a windfall, because a windfall can only raise and not reduce the marginal contributions of an individual. In contrast, it is possible that the nucleolus could reduce a person's allocation after the group receives a windfall.¹¹⁶

III. THE APPLICATION OF FAIR DIVISION METHODS TO COPYRIGHT AND PATENT LAW

A. *The Treatment of Minor Collaborators*

The patent and copyright case law take a similar approach to defining the status of inventor or author. People who suggest the idea for an invention or expressive work are excluded. People who reduce an invention to practice (e.g., by testing or making a prototype), and people who fix an expressive work under close supervision of the author are excluded. People who provide material contributions to an invention or expressive work are excluded. The main difference is the treatment of minor contributors. In patent law a person who contributed to the conception of only a few claims is fully recognized as a joint inventor. Copyright law tends to exclude a minor contributor from joint authorship and instead characterizes her as an author of a derivative work.

*Ethicon, Inc. v. U.S. Surgical Corp.*¹¹⁷ presents a vivid illustration of patent law treatment of minor inventors. A surgeon and inventor of surgical instruments named Yoon obtained a patent on a device called a trocar which he licensed to Ethicon for more than \$15 million. He excluded a co-worker named Choi from the patent. Choi had no familiarity with surgical instruments, but he did have skills in electronics and he designed electronic sensors that appeared in two of the fifty-five claims.¹¹⁸ The court held that Choi was a joint inventor. Joint invention occurs when two or more people each contribute to the conception of the invention.¹¹⁹ Conception is as a definite and

¹¹⁶ Dane S. Ciolino, *Reconsidering Restitution in Copyright*, 48 EMORY L.J. 1, 21 (1999) (“Nor is there a compelling reason why the copyright owner should be permitted to recover a monetary windfall far in excess of his greatest expectations.”)

¹¹⁷ 135 F.3d 1456 (Fed.Cir. 1998).

¹¹⁸ Ethicon sued for infringement of claims 34 and 50, and Choi was a coinventor of the devices in claims 33 and 47. *Ethicon, Inc. v. U. S. Surgical Corp.*, 135 F.3d 1456, 1459 (Fed. Cir. 1998). Since Choi gains rights to all the claims in the patent he was able to license US Surgical to practice claims 34 and 50. *Id.* at 1465-66.

¹¹⁹ It is not sufficient that two inventors work for the same firm. *See Kimberly-Clark v. Proctor & Gamble*, 973 F.2d 911, 912, 917 (Fed. Cir. 1992). Researchers were working in the same firm but they did not work together. The Federal Circuit held, “for persons to be joint inventors under section 116, there must be some

permanent idea of the complete and operative invention.¹²⁰ Choi did contribute to the conception of the claims featuring the electronic sensors so he qualified as a joint inventor.

A joint inventor, even a relatively minor contributor, is a joint owner of everything claimed in a patent.¹²¹ That aspect of patent law was critical in *Ethicon*, because the defendant tracked down Choi, informed him that he was a joint inventor of the patented trocar, and then obtained a license from him, even though the defendant was not using the technology described in the claims that Choi co-invented.¹²² The dissenting judge argued that the status of joint inventor does not necessarily imply equal ownership rights,¹²³ and a minor inventor like Choi should only enjoy ownership of the claims that he co-invented.¹²⁴

*Thomson v. Larson*¹²⁵ makes the contrast between patent and copyright law clear. Both claimants made copyrightable contributions to the musical but copyright law requires evidence of mutual intent to establish joint authorship,¹²⁶ and the court found

element of joint behavior, such as collaboration or working under common direction, one inventor seeing a relevant report and building upon it or hearing another's suggestion at a meeting."

¹²⁰ *Hybritech, Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1376, 231 U.S.P.Q. (BNA) 81, 87 (Fed. Cir. 1986) (quoting 1 Robinson on Patents 532 (1890)). "An inventor must produce appropriate corroborating evidence that would persuade a person having ordinary skill in the art that the inventor possessed the invention. The conception must be sufficiently definite so that ordinary skill in the art is sufficient to achieve reduction to practice."

¹²¹ Anyone who contributes to conception of at least one claim must be named on the patent. Joint inventors do not need to work together. The junior collaborator is still a joint inventor even though "the major share of the inventive effort is accomplished by one joint inventor working alone prior to the collaboration." See *Shields v. Halliburton*, 667 F.2d 1232, 1235 (5th Cir.1982).

¹²² *Ethicon, Inc. v. U.S. Surgical Corp.*, 937 F.Supp. 1015, 1019 (D.Conn.,1996) ("Choi granted U.S. Surgical an exclusive license to practice his 'trocar related inventions;' authorized U.S. Surgical to bring an action to correct the patent to add him as a coinventor; promised to assist U.S. Surgical in connection with the action by providing information and testimony; and agreed to join the action as a party. U.S. Surgical agreed to pay Choi \$300,000 on execution of the agreement and make future payments to him of up to \$1 million contingent on the outcome of the litigation.") *Id.* at 1020 (by 1996 Ethicon had paid Yoon more than \$15 million for his invention).

¹²³ In her dissenting opinion, Judge Pauline Newman noted "The ownership relationships among the persons who, under § 116, could now be recognized as contributors to the invention, is irrelevant to the purpose of the amendment of § 116, and to its consequences." 135 F.3d 1456, 1470 (Fed. Cir. 1998). Pub. L. 98-622, § 104, 98 Stat. 3384, Nov. 8, 1984. "This amendment did not also deal with the laws of patent ownership, and did not automatically convey ownership of the entire patent to everyone who could now be named as an inventor, whatever the contribution."

¹²⁴ Judge Newman concluded "it is not an implementation of the common law of property, or its statutory embodiments, to treat all persons, however minor their contribution, as full owners of the entire property as a matter of law. The law had never given a contributor to a minor portion of an invention a full share in the originator's patent." *Id.* at 1471. Right to partition goes to each joint owner. *Ethicon* at 1472 n.10 (Newman, J., dissenting) (citing *Hamilton v. Hamilton*, 597 A.2d 856, 859-60 (Del. Fam. Ct. 1990)).

¹²⁵ 147 F.3d 195 (2nd Cir. 1998).

¹²⁶ The copyright statute requires merely that the authors intend their contributions to merge into an inseparable whole. To guard against the possibility that someone (like an editor) who makes a small expressive contribution might be considered a joint author *Childress v. Taylor* added a requirement to the statute. The *Childress* court requires that each of the putative co-authors (1) made independently copyrightable contributions to the work; and (2) fully intended to be co-authors. See also *Aalmuhammed v. Lee*, 202 F.3d 1227 (9th Cir. 2000) (motion picture co-authors must supervise and control the making of the movie).

plenty of evidence that Larson did not intend that Thomson be a joint author.¹²⁷ Instead of being recognized as a joint author of the entire work, Thomson qualified as the author of a derivative work that incorporated the original version of the musical. It is possible for an author in Thomson's situation to do quite well if a court would enjoin performance of the final version of the musical. That would have given Thomson a strong bargaining position. Though it was not decided, it is more likely that the court would have found Thomson implicitly extended a license to Larson allowing him to use the improvements she contributed. If so, the judge would have decided whether Thomson was entitled to any additional royalties under the implicit license.

The proposal by the dissent in *Ethicon* to partition patent ownership by claims and the tendency in copyright cases to find a derivative work and an implicit license reflect a desire to give minor collaborators a reward proportionate to their contribution.¹²⁸ My analysis of two-party collaboration suggests two factors that should be considered when deciding what reward to a minor collaborator is fair. If the expected profit from collaboration is large, then equal sharing is appropriate unless the difference in the stand-alone values of the collaborators is large. If the expected profit from collaboration is small, then courts should be cautious about equal sharing outcomes; they should make sure that each collaborator gets at least her stand-alone profit.

For purposes of illustration I assume that the expected profit from collaboration in *Ethicon* was large because Yoon had a good track record as an inventor,¹²⁹ and the expected profit from collaboration of Larson and Thomson was small because Larson was a relative newcomer. Despite high expected profit, equal profit sharing is not appropriate in *Ethicon* because Yoon had much better exit options than Choi, in other words, there was a large difference in their stand-alone profit. Despite low expected profit in *Larson* it is hard to reject equal profit sharing because there is not much evidence suggesting a difference in stand-alone values.

Two other factors suggested by the analysis of three-party collaboration also need to be considered. A person's status as either essential or replaceable has a significant bearing on fair division. So does evidence that a person has a high (or low) average marginal contribution. Before applying these other factors, I need to justify applying

¹²⁷ The mutual intent test is not strictly subjective. Joint authorship can exist even without an explicit agreement. Intent is particularly important when one person (like Larson in this case) is a dominant author. Three factors are helpful in assessing intent: (1) the allocation of decision-making authority; (2) billing; and (3) written agreements with third parties. See *Childress v. Taylor*.

The decision-making authority was allocated to Larson who agreed to let the NY Theater Workshop's hire Thomson as a dramaturg to assist him in clarifying the storyline. Her contract called for a fee of \$2000 to provide dramaturgical assistance and research to the playwright and director. Larson was billed as the sole author and composer. Thomson was billed as the dramaturg. Larson's contract with NYTW gave Larson approval rights over all changes in text, provided any changes in text would become his property, and assured him billing as the sole author.

¹²⁸ *Ethicon, Inc. v. U. S. Surgical Corp.*, 135 F.3d 1456, 1468-72 (Fed. Cir. 1998) (Newman, J., dissenting) (arguing that an inventor who contributed to a single claim in a patent was over rewarded by an equal ownership interest in all claims granted in the patent). *Childress v. Taylor*, 945 F.2d 500, 507 (2nd Cir. 1991) (opposing joint authorship status for minor contributors who would be over rewarded by "an undivided half interest in the copyright in the published work"); F. Jay Dougherty, *Not a Spike Lee Joint? Issues in the Authorship of Motion Pictures Under U.S. Copyright Law*, 49 U.C.L.A. L. REV. 225, 326 (2001) (joint work owners are entitled to a share proportionate to their contributions)

¹²⁹ Yoon organized the venture and had previous success in the field. *Ethicon* at 1459. "Yoon is a medical doctor and inventor of numerous patented devices for endoscopic surgery.

insights from three-party collaborations to what appear to be two-party collaborations. The example in Table Five is helpful in forging the link.

$v(A) = 0$	$v(B) = 0$	$v(C) = 0$
$v(A,B) = X$	$v(A,B) = X$	$v(B,C) = 0$
	$v(A,B,C) = X+Y$	
Shapley value to A:	$2X/3 + Y/3$	
Shapley value to B and C:	$X/6 + Y/3$	
Nucleolus to A:	X	
Nucleolus to B and C:	$Y/2$	

Table Five

Table Five lists the payoffs to collaborators A, B, and C.¹³⁰ Imagine that A is Larson, B is Thomson, and C is another dramaturg who could provide services comparable to Thomson. Let $X = 6$, and $Y = 0$. Notice that A is essential to the collaboration; there is no value produced without A. B and C play a symmetric role in the collaboration; only one of the two is necessary. I introduce a fictitious second dramaturg because I suppose there was at least one other choice at the time the New York Theater Workshop hired Thomson.¹³¹ Therefore, if the parties had negotiated for a fair division of the collaborative profit at the time Thomson was hired, the possibility of an alternative dramaturg would have influenced their notions of fairness.

The solution to the problem in Table Five is vastly different depending on whether the Shapley value or the nucleolus is used. The nucleolus gives the surplus of 6 to A. The Shapley value only gives 4 to A. The nucleolus gives all of the surplus to A because A is essential and B can be perfectly replaced with C. Fairness in the sense of the nucleolus is linked to notions of bargaining; A should get the entire surplus because B and C would compete away their share of the profit in order to get hired. The Shapley value recognizes that B or C each has some probability of bringing value to the collaboration and rewards them accordingly. Applying these results to *Larson*, if the nucleolus represents the appropriate concept of fair division, and if Thomson was replaceable, then it is fair to give all the collaborative profit to Larson. If the Shapley value represents the appropriate concept of fair division, then skills brought to the collaboration by Thomson are a significant source value and Thomson should be compensated.¹³² Similar comments apply to *Ethicon*. The Shapley value approach

¹³⁰ Assume $X > Y$, so that the value of a two person coalition including A is greater than the incremental value of adding the third collaborator to that coalition.

¹³¹ It is important to recall the definition of collaboration requires thin input markets, therefore, there cannot be too many choices of dramaturgs with the same skills as Thomson.

¹³² Not with an equal share though. The Shapley value gives 4 to A, 1 to B, and 1 to C, or Larson gets 4, and Thomson and the other dramaturg each get 1 unit of profit. The best interpretation of this result is that Thomson and the other dramaturg are equally likely to be chosen for the collaboration, and when chosen they get 2 units of profit. The expected value of the profit to Thomson from a hypothetical fair division reached before the hiring decision is 2 times probability (1/2) equals 1. Thus, Larson should get two-thirds of the profit and Thomson the other third. Finally, note that Larson's fair share under the Shapley value gets larger as the number of potential replacements for Larson grows.

recognizes that Choi had electronic skills Yoon lacked,¹³³ and so Choi deserves a share of the collaborative profit.¹³⁴ But the nucleolus approach emphasizes that Yoon was the key inventor,¹³⁵ and Choi quite likely was replaceable, therefore he does not deserve to share in the collaborative profit. To summarize, three factors are relevant to determining the fair division of the profit between a major and a minor collaborator: the difference in exit options of the collaborators, whether the minor collaborator is replaceable, and the average size of the marginal contributions made by the minor collaborator.

B. *The Boundaries of Inventorship and Authorship*

The definition of collaborator used in this Article is broader than the definitions of inventor or author in patent and copyright law.¹³⁶ A collaborator provides a service in a thin input market, and joins other collaborators in a team production process. A person who contributes an abstract idea to the creation of an invention or work of authorship could meet the definition of collaborator — so could a person who reduces an invention to practice. A person subject to the copyright law work made for hire doctrine should sometimes be viewed as a collaborator with her employer. Employees and people who reduce an invention to practice can gain their fair share of the profit from collaboration by contracting in advance, but if they fail to contract the law offers little protection to them after the fact. In contrast, there is state law protecting persons whose ideas are misappropriated.¹³⁷ Courts should be guided by the principles discussed above when they select a fair division of the profit between an idea developer and the party or parties who use it to create intellectual property.¹³⁸ Courts should also use those principles to help decide close cases concerning whether a person qualifies as an author or inventor, or whether the work made for hire doctrine should apply.

¹³³ *Ethicon, Inc. v. U.S. Surgical Corp.*, 937 F.Supp. 1015, 1020 (D.Conn.,1996) (“[Yoon] does not understand basic terminology relating to electronics and is incapable of drawing circuits. Mindful of the limited nature of his own knowledge, he has looked for people with expertise in electronics and engineering to assist him in connection with his projects.”) 1020 (“Choi does not have Yoon’s credentials as a scientist or inventor. However, he was qualified to collaborate with Yoon in a joint effort to develop a safer trocar because of his training and experience in electronics.”)

¹³⁴ Assuming the trocars with Choi’s sensors had some value beyond the trocars without sensors.

¹³⁵ “[T]he district court recognized that Dr. Yoon originated the fundamental concept and the major aspects of its implementation.” *Id.* at 1471-72.

¹³⁶ Philip W. Grubb, *Patents for Chemicals, Pharmaceuticals and Biotechnology: Fundamentals of Global Law, Practice and Strategy* (1999). p. 347 “[I]t is quite possible for the actual inventive step to involve the least mental effort of any of the steps necessary to attain a working invention, and it is a defect of schemes of compensation for employee inventors that they reward only the persons who according to patent law are the inventors, even though others who are not inventors may have contributed more.” “[C]ollaboration alone is not sufficient to establish joint authorship. Rather, the contribution of each joint author must be independently copyrightable.” Thomson, 147 F.3d at 200.

¹³⁷ Trade secret law. *Id.* Idea misappropriation. *Desny v. Wilder*, 46 Cal.2d 715 (Cal. Sup. Ct. 1956) (state law protection of idea for a movie); *cite* (state law protection of idea for invention); *see generally* 4 Melville B. Nimmer & David Nimmer, *Nimmer on Copyright* §16.03 - §16.05 (explaining that quasi-contract, express contract, and implied contract theories can all be used to support state claims relating to idea submission); Robert P. Merges, Peter S. Menell, & Mark A. Lemley, *Intellectual Property in the New Technological Age* 827-29 (2000) (describing informal industry practices that protect submission of toy concepts and movie and television scripts).

¹³⁸ *See* 4 Melville B. Nimmer & David Nimmer, *Nimmer on Copyright* §16.05, at 16-44.1 (suggesting that courts should determine an appropriate price for an implied contract governing idea submission).

Patent and copyright law exclude people from inventorship or authorship if their only contribution is to suggest a project or offer an abstract idea that someone else develops into an invention or expressive work.¹³⁹ This rule seems appropriate in cases in which the person contributing the idea is easily replaced as illustrated by *Hess v. Advanced Cardiovascular Systems, Inc.*¹⁴⁰ The alleged joint inventor recommended the type of material that should be used in a balloon suitable for angioplasty. The court found this information was readily available in the prior art and ruled against the plaintiff.¹⁴¹ The rule is harder to defend in a case like *Community for Creative Non-Violence v. Reid*.¹⁴² Snyder and the CCNV conceived of a sculpture of a homeless family huddled on a steam grate for warmth. Snyder enlisted a sculptor named Reid in the project and directed him to create a sculpture that would evoke a Nativity scene. A court could characterize Snyder's contribution as strictly idea.¹⁴³ But the line between idea and expression is hard to draw, and a court might characterize Snyder's contribution as expression as well as idea. The fuzziness of this boundary gives courts some latitude to assure fair division of the profit from collaboration. The essential nature of Snyder's contribution helps make a case for considering him a joint author.¹⁴⁴

The other main boundary line that separates authors and inventors from other collaborators relates to implementation of the invention or expressive work. A person cannot become a joint inventor by building and testing an embodiment.¹⁴⁵ Consider for example *MacMillan v. Moffett*,¹⁴⁶ a case in which the defendant selected 69 compounds as candidates for an antiperspirant. The plaintiff tested them for effectiveness. One of the compounds was effective and patented. The court denied the plaintiff's claim to joint inventor status because the plaintiff only participated in reducing the invention to

¹³⁹ To establish joint authorship the contribution of each author must be copyrightable. Each author must supply more than direction or ideas. *Erickson v. Trinity Theatre, Inc.*, 13 F.3d 1061 (7th Cir.1994)(?)

¹⁴⁰ 106 F.3d 976 (Fed. Cir. 1997).

¹⁴¹ See *Hess v. Advanced Cardiovascular Systems, Inc.*, 106 F.3d 976 (Fed. Cir. 1997). The defendants were two doctors who filed a joint patent for the invention of a balloon angioplasty catheter. The doctors got advice from the plaintiff regarding what material to use to make the balloon. The plaintiff claimed joint inventor status based on his contribution to the conception of the invention. The court rejected his claim because the information he provided was well known.

¹⁴² 490 U.S. 730 (1989).

¹⁴³ The case was remanded to determine whether CCNV was a joint author of the sculpture. During the creation of the sculpture Snyder made several suggestions about the design and rejected certain proposals by Reid. Further, the D.C. Circuit mentioned that "the steam grate pedestal is [not] so insignificant a contribution to the work of art that it fails to reflect the requisite 'originality' and 'authorship.' The standard for determining whether a creation is an 'original work of authorship' is not high."

¹⁴⁴ A good contrast is found in *Childress v. Taylor*. Childress was "indisputably the dominant author." *Id.* at 508.

¹⁴⁵ See Donald S. Chisum, *Understanding Intellectual Property Law*, 2-172 (1992). Ethicon at 1469 (Newman, J., dissenting) "The purpose of the amendment of § 116 was to remedy the increasing technical problems arising in team research, for which existing law, deemed to require simultaneous conception as well as shared contribution by each named inventor to every claim, was producing pitfalls for patentees, to no public purpose." The Patent Act was amended in 1984 to loosen the definition of joint inventor. Joint invention occurs even though the inventors: (1) "did not physically work together or at the same time, (2) each did not make the same type or amount of contribution, or (3) each did not make a contribution to the subject matter of every claim of the patent." 35 U.S.C.S § 116. But joint inventor status is still constrained by the requirement than an inventor contribute to the conception of an invention.

¹⁴⁶ 432 F.2d 1237 (C.C.P.A. 1970).

practice.¹⁴⁷ If testing is provided in a competitive market, or if it is easy to separate the value of the testing from the contributions of the defendant, then the case for inventorship is weak because the person doing the tests is not a collaborator. If the tester is a collaborator, but it easily replaced, then a court influenced by the nucleolus approach to fair division would reject the claim of inventorship. But a court more sympathetic to the Shapley value approach might find the significant marginal contribution of the tester to justify a claim to the patent profits.¹⁴⁸

Comparable cases in copyright law are hard to find because parties involved in implementing an expressive work are usually hired from competitive markets or at least are fairly easy to replace. In *Andrien v. Southern Ocean County Chamber of Commerce*,¹⁴⁹ real estate agent Andrien assembled and combined a set of maps into a single map. He measured distances to properly correlate the different maps. He also added street names, and landmarks. He contracted with a printing firm to prepare the map. The firm assigned Haines to do artwork. Andrien directed Haines as she photographed various maps to synchronize the scale and typed labels for street names. The district and circuit court agreed on sole authorship, but disagreed about who that author was. The district court judge awarded copyright ownership to the printing company. He ruled that Andrien did not fix his idea as a tangible expression and he was not a joint author since he only supplied ideas about the map. The circuit court reversed, holding that Andrien was the sole author. The circuit court viewed the work of Haines as routine activity that was closely directed by Andrien.¹⁵⁰ She did not intellectually modify

¹⁴⁷ The MacMillan court stated, “We do not think that the conceiver must know the unexpected properties associated with conceived invention, nor even that the conceived subject matter is a new. These facts are of course relevant to patentability, but there is no requirement in the law that a conceiver be aware of the facts, which render the conceived subject matter patentable.” *Id.* at 1239. See also Donald S. Chisum, *Understanding Intellectual Property Law*, 2-172 (1992). (“One who conceives of a complete invention is a sole inventor even though another discovers its novelty or distinguishing features.”)

¹⁴⁸ *Burroughs Wellcome Co. v. Barr Labs., Inc.*, 40 F.3d 1223 (Fed. Cir. 1994) presents a fact pattern where it is tempting to characterize testing as contributing to conception as well as reduction to practice. Defendants attacked six patents for failure to include NIH inventors. The Federal Circuit agreed that five of the patents relating to AZT and the use of AZT to treat HIV were valid, because the NIH investigators were not joint inventors. They remanded the ‘750 patent for further analysis on that issue. BW researchers discovered that AZT was effective against two mouse retroviruses. They sent the compound to the NIH for testing against HIV in the ATH8 patented cell line. The NIH reported that AZT was effective against HIV. The court ruled that the NIH testing was not part of the conception of the inventions — BW already conceived of the structure of AZT and the method of using it to treat AIDS. The ‘750 patent claimed the use of AZT to raise T cell counts in AIDS patients. BW researchers sent a sample of AZT to the NIH to conduct a Phase I study. The NIH researchers determined that AZT raised T cell counts. The (partial) dissent argues that an increased T cell count was an inherent property of the invention. The PTO held that the claims in the ‘750 patent are obvious in light of the other AZT patents and the inventor agreed to a terminal disclaimer.

¹⁴⁹ 927 F.2d 132 (3rd Cir. 1991).

¹⁵⁰ Andrien was able to claim author status because he directed the process of converting his ideas into an expression. Mere encouragement is not sufficient. In *Childress v. Taylor*, Taylor wrote a script for a play about the life of Moms Mabley. The script didn’t work. She contacted Childress about writing a script. Taylor wanted to star in a show about Mabley. Childress wrote the script, but had disagreements with Taylor and broke off their relationship. Taylor was not credited as a co-author because she supplied only ideas and encouragement.

or technically enhance the concept authored by Andrien.¹⁵¹ This outcome seems appropriate since Haines provided skills available in a competitive market.

Most inventors and many authors are not self-employed. Most employees promise to assign their patents and copyrights to their employer. The common law sometimes shifts ownership of patents from employees to their employers, and copyright law usually shifts ownership to employers. Under the common law a patent must be assigned to an employer if the employee-inventor was hired to invent.¹⁵² Furthermore, when an employee who was not hired to invent gets a patent on an invention created within the scope of her employment duties, or with the aid of company resources the employer gets a royalty-free license.¹⁵³ Under the Copyright Act a work prepared within the scope of employment¹⁵⁴ and some kinds of specially commissioned works are considered works made for hire, and the employer owns the copyright.¹⁵⁵

Of course, the initial ownership rights are only part of the story. Many employees assign their patents and copyrights to their employer via contract.¹⁵⁶ These contracts are regulated to a small degree by state labor law.¹⁵⁷ It is a difficult question of economic

¹⁵¹ There is room for a middle ground in this case. The courts could have chosen joint authorship by finding that Andrien's contribution was not too abstract, and that Haines's contribution was not too routine and controlled by Andrien.

¹⁵² *United States v. Dubilier Condenser Corp* 289 U.S. 178, 187 (1932). Donald S. Chisum, *Understanding Intellectual Property Law*, § 2G[1] (1992). Robert P. Merges, *The Law and Economics of Employee Inventions*, 13 *Harv. J. Law & Tech.* 1, 5 (1999). 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).

¹⁵³ Donald S. Chisum, *Understanding Intellectual Property Law*, § 2G(1) (1992). *See Merges supra* note x at 5-6 (the license is known as a shop right).

¹⁵⁴ Even when someone is an employee, the work made for hire doctrine only applies to works made within the scope of employment. *See Avtec Sys., Inc. v. Peiffer*, 21 F.3d 568 (4th Cir. 1994). The scope of employment is determined by common law standards. The Restatement (Second) of Agency says that "the putative employer has the burden of showing: (1) the work was the type which the individual was hired to perform; (2) the creation occurred within the time and space limits of the job; and (3) the work serves the interests of the putative employer." In this case even though Peiffer was granted a copyright on a program made outside the scope of employment he still faced constraints from trade secret law and a non-compete clause.

¹⁵⁵ *See Community for Creative Non-Violence v. Reid*, x U.S. x (19xx); Rochelle Cooper Dreyfuss, *The Creative Employee and the Copyright Act of 1976*, 54 *U. Chi. L. Rev.* 590 (19xx); I.T. Hardy, *An Economic Understanding of Copyright Law's Work-Made-For-Hire Doctrine*, 12 *Colum.-VLA J.L. & Arts* 181 (1988).

¹⁵⁶ *See Merges supra* note x at 7 (most R&D and many other employees sign a contract that assigns their patents to their employer); In *United Aircraft Products v. Warrick*, defendant signed a contract, which gave the company rights to assignment of any discovery made during the course of his employment. The Court of Appeals of Ohio, ruled that the contract was valid and enforceable and thus affirmed the ruling of the lower court which granted specific performance of the contract for the assignment of the invention to the company. 72 N.E.2d. 669, 670-1 (Ohio. 1945); *Counsel for Publishers, Writers Square Off Over Tasini Ruling*, 59 *BNA Patent, Trademark & Copyright Journal* 381, 383 (Dec. 17, 1999) (the New York Times requires express transfer of copyrights from free-lancers). In contrast, Harper's Magazine has a policy of sharing royalties from electronic re-use with authors. John B. Kennedy and Shoshana R. Dweck Publishers, *Authors Battle Over Electronic Rights*, *The National Law Journal* (p. C17), Monday, October 28, 1996. "Before the advent of electronic publishing and distribution, freelancers generally granted to publishers at minimum a one-time print publishing right for a flat fee, with additional fees for translations, reprints and other re-uses or modifications of the original works. The freelancers retained all other rights, including movie, television and other adaptation rights." *Id.*

¹⁵⁷ The California labor code § 2870 restricts employee's invention assignment agreements. *Cal Lab Code* § 2870 (2000). A contract that purports to require an employee to assign patents on inventions unrelated to

theory to determine how well employees do in extracting surplus from the intellectual property they create. Many non-economists doubt that employees get much benefit at all by assigning their intellectual property to their employers. There are two factors that suggest some employees get a meaningful share of patent surplus. First, many employers have internal reward systems for inventors.¹⁵⁸ And second, employees have the option of leaving the firm with an inventive concept before it is developed so far that it is ready to patent, this threat gives employees bargaining power.¹⁵⁹

The principles developed in this Article are useful in resolving close questions about the terms of an assignment contract or the applicability of the work made for hire doctrine. A court should lean in favor of the employee in cases in which the employee has a strong exit option, is not easily replaced, and was expected to provide a large marginal contribution. The copyright case law seems to conform to these principles. In *CCNV v. Reid*, the Supreme Court clarified the meaning of employment in the context of the work made for hire doctrine. The Court chose to rely on common law principles of agency.¹⁶⁰ It ruled that Reid was an independent contractor because he practices a skilled occupation, used his own tools, worked in his own studio, and worked for CCNV for less than 2 months.

C. Cumulative Invention and Authorship

Return to Table Five, and recall the fair division problem described in the introduction. Suppose that person A holds a patent on an invention or a copyright on an expressive work. Suppose that A's creation can be profitably modified in one of two ways by either B or C. One modification generates a value of 6 and the other a value of 3. B and C can both do either modification, but they can only do one modification each. This set of assumptions leads to the problem in the introduction, and to the problem in Table Five when $X = 6$ and $Y = 3$. Referring to Table Five notice that the nucleolus gives a profit of 6 to A, and $(3/2)$ to B and C. The Shapley value gives 5 to A and 2 to B and C.

As discussed above, the nucleolus gives the entire value of the first modification to A. This means that if $Y = 0$, then the nucleolus awards the pioneer the entire surplus from cumulative creation. The nucleolus provides support for the fairness of strong property rights to a first creator. The Shapley value only gives two-thirds of the profit to A when $Y = 0$. It tends to give more of the surplus from cumulative creation to improvers.

[To be completed.]

work made without use of employer resources is not enforceable. In *Ingersoll Rand Co. v. Ciavatta*, 542 A.2d 879, 880-1 (N.J. 1988) the court refused to enforce a trailer clause that called for assignment of patents based on inventions conceived within one year after employment is terminated. The court found that the invention did not use any of the previous employer's trade secrets. The court refused to apply the trailer clause because of the public interest in competitive research.

¹⁵⁸ See *Merges supra* note x at 4.

¹⁵⁹ See *id.* at 47. Employee bargaining power is constrained by the threat of trade secret litigation, *Id.* at 47, and trailer clauses that require employees to assign their right to inventions created for a certain time after their employment ends. *Id.* at 53.

¹⁶⁰ In *Aymes v. Bonelli* the question arises whether a programmer is an independent contractor or an employee. The court considered five factors: (1) hiring party's right to control the manner and means of the creation; (2) the skill required; (3) the provision of employee benefits; (4) the tax treatment of the hired party; and (5) whether the hiring party has the right to assign additional projects to the hired party.