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PARITY ANALYSIS: TOPOLOGICAL CONSIDERATIONS FOR PATENT VALUATION AND PORTFOLIO MANAGEMENT

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INTRODUCTION

Lanchester's laws of warfare, developed in 1905, are intended to reflect the time-dependent attrition of two opposing armies based upon their relative fighting capability.[1] Particularly:

$$\frac{dA}{dt} = -c_2 B \quad (1)$$

$$\frac{dB}{dt} = -c_1 A \quad (2)$$

where t is time, A reflects the number of units in a first army, B the number of units in a second army, c_1 the efficiency ratio, or per-unit capability enhancement, of the A army, and c_2 the per-unit capability enhancement of the B army.[2] For example, if the first army consists of 150 individuals (A=150) armed with their fists (c_1=1), and the second army consists of 90 individuals (B=90) armed with machine guns (c_2=4), one would expect the conflict to resolve after ~0.6 time steps with zero units of A and 49 units of B remaining.[3]

One can divide the second equation by the first, or apply the chain rule, to derive a "square" form, directly relating the relative power of each army at each instant:

$$\frac{dB}{dA} = \frac{c_1 A}{c_2 B} \quad (3)$$

This square form provides a useful quick assessment of the relative "parity" of the two armies. For example, so long as B's power ($c_2 B$) is at least twice A's power ($c_1 A$) then B will lose no more than half as many units

1. Frederick William Lanchester, *Mathematics in Warfare*, 4 THE WORLD OF MATHEMATICS, 2138, 2138 –57 (James R. Newman ed., 1956).
2. *Id.*
3. Incidentally, a rigorous assessment of even these simple equations requires some knowledge of calculus. This example applies Laplace transforms to determine the solution.

as A at each timestep. Thus, to a certain extent, the Lanchester equations simply make intuition rigorous.

The simplicity of this grim calculus facilitates its application in domains outside warfare. For example, one can model supply chains, marketing strategies–and competing patent portfolios–using the Lanchester equations.[4] Indeed, this paper asserts that patent portfolio managers regularly, implicitly or explicitly, apply the "square" form for parity assessment between patent portfolios. Managers regularly threaten "nuclear war" and "reciprocal annihilation," celebrating their portfolio's *size* and *quality* as though these were proxies for *A* and c_1 respectively.[5]

However, just as terrain, weather, supply chains – in a word "topology" – can radically mitigate these equations' ability to predict outcomes in warfare, so can business and product topologies radically modify a patent portfolio's value.[6] Indeed, many practitioners acknowledge that topological factors affect portfolio value and accordingly encourage managers to include "corporate strategy" in their portfolio management.[7] Unfortunately, this

4. *See, e.g.*, Miltiadis Chalikias, Panagiota Lalou, & Michalis Skordoulis, *Modeling a Bank Data Set Using Differential Equations: The Case of the Greek Banking Sector*, 5TH INT'L SYMPOSIUM AND 27TH NAT'L CONFERENCE ON OPERATIONAL RESEARCH (2016) (discussing F.W. Lanchester's combat model application in a supply in a duopoly); *Lanchster Equations and Scoring Systems*, RAND CORP., https://www.rand.org/pubs/monograph_reports/MR638/app.html (last visited Feb. 19, 2019); *Why Lanchester Strategy For Sales and Marketing?*, LANCHESTER STRATEGY http://lanchester.com/ (last visited Mar. 18, 2019).

5. *See, e.g.*, Bianca Bosker, *Steve Jobs Said He'd "Go Thermonuclear War" On Google Over iPhone Theft*, HUFFINGTON POST (Oct. 20, 2011, 9:11 PM), https://www.huffingtonpost.com/2011/10/20/steve-jobs-google-grand-theft_n_1023111.html; Joe Mullin, *Patent War Goes Nuclear: Microsoft, Apple-Owned "Rockstar" Sues Google*, ARSTECHNICA (Oct. 31, 2013, 10:10 PM), https://arstechnica.com/tech-policy/2013/10/patent-war-goes-nuclear-microsoft-apple-owned-rockstar-sues-google/ (describing the exorbitant $4 billion price paid by RockStar); WIKIPEDIA, https://en.wikipedia.org/wiki/Patent_war (last visited Feb. 19, 2019); *This American Life: When Patents Attack*, NATIONAL PUBLIC RADIO (NPR) (July 22, 2011), https://www.npr.org/sections/money/2011/07/26/138576167/when-patents-attack. Note how these articles and references discuss the patents as entities independent of the parties against which they are being, or are to be, asserted, instead overemphasizing the size and scope of the portfolio, and, in some cases, how much the parties paid for the portfolio.

6. *See infra* Section I. Incidentally, one might also conclude that the Lanchesterian reasoning is faulty in the patent domain as "patents don't kill patents." While this is also often a valid criticism, in some topological situations, patents *can* "kill" other patents' value, at least in the sense of negating the leverage the patents provide. The below discussion concerning claim topological factors, particularly concerning royalty value, discusses this phenomenon in greater detail.

7. *See, e.g.*, LARRY M. GOLDSTEIN, PATENT PORTFOLIOS: QUALITY CREATION, AND COST 26–27 (2015) (acknowledging that "a company must make a conscious decision that it wants a strategy for its patents, it must decide what that strategy will be, and it must then implement that strategy" inviting participation from top executives. However, the text doesn't then offer any specific methodology beyond this general admonishment); *But see*, WILLIAM J. MURPHY, JOHN L. ORCUTT, & PAUL C. REMUS, PATENT VALUATION: IMPROVING DECISION MAKING THROUGH ANALYSIS 67–103 (2012) [hereinafter "MURPHY"]. This footnote is not to impugn the quality of these books; they are indeed fine starting points

encouragement often manifests itself as a more refined Lanchesterian analysis.

Particularly, when managers do assess their portfolio position relative to a competitor (and they often do not[8]) they do so by employing a "categorization and ranking" analysis. In this analysis, the manager will identify domains of business interest and retain a law firm to sort patent claims in their portfolio and in their competitor's portfolio into each of these domains. The law firm will then rank assets within each category based upon the asset's likely enforceability.[9] The relative number of "high quality" ranked assets in the most highly valued of the categories then determines the quality of one portfolio relative to another. Topology, the practitioner might argue, is being sufficiently captured in this process via the categorization into domains of business interest.

However, the astute reader will have recognized that this process merely applies Equation 3 at a categorical level, rather than at the portfolio-wide level. The *number* of assets in each category and their *enforcement quality* remain crude proxies for A and c_1 under this analysis, as their *specific* topological displacement influences on the *specific* competitor being analyzed remain unconsidered.[10] Categorization and ranking are thus not unlike assessing an ongoing chess game by considering the *number* and *types* of pieces on the board (i.e., patents in each category), without considering

recommended to the reader. However, since they do not provide a methodology for strategic *topological* consideration, the Author's experience is that practitioners despair of a more thorough analysis and instead apply these books' teachings within the Lanchesterian approach (and even then, rarely to a specific competitor in that market, let alone entities outside the market). Murphy *does* provide thorough and useful discussions of decision-making decomposition. *See id.* 67–87. Murphy also provides a useful discussion of isolated patent valuation. *See id.* 89–231. But both sources do not discuss competitor topology. Practitioners seem to conclude that it is simply too expensive and time-consuming to apply these methods to creatively explore "hypothetical" topological relations and considerations (See *infra* Section III.C for a response to this issue.)

8. *See infra* Section III.A and treble patent damages discussion.

9. This is also regularly done with SEO and standards-setting FRAND and, indeed, is much of the cost involved with those organizations.

10. Law firms may celebrate this approach for the revenues it generates. Per the Lanchester laws "more is always better" (increasing *A* and *B*) and retaining practitioners to accumulate endless patent portfolios, therefore, seems always to have merit. Similarly, shareholders, assuming more is better, may favor corporations with, and encourage corporations to have, large portfolios. Lanchesterian reasoning may have also been part of Intellectual Property Exchange International ("IPXI")'s downfall, as Lanchester's methodology *implies* the fungibility of operating units, when in fact, as discussed extensively herein, that is very much not the case for patents. *See, e.g.*, Merritt L. Steele, *The Great Failure of The Ipxi Experiment: Why Commoditization of Intellectual Property Failed*, 102 CORNELL L. REV. 1115, 1135 (2017) ("IPXI needed 'artificial scarcity' in order to create a commodities market for licenses. Unlike the agricultural products sold on the original Chicago Mercantile Exchange, licensing rights are an intangible good with a non-depletable supply.").

the pieces' relative *positions* (their displacing effect on each competitor).[11] Having two queens may be "better" than two rooks in the abstract, but two rooks are sufficient to place you in checkmate regardless. Often, topological factors remain neglected until the practitioner enters a licensing (or litigation) discussion with a specific target, at which point it is too late to structure the patent portfolio in anticipation of topology meaningfully.[12]

By omitting topology, the Lanchesterian approach often misrepresents the actual leverage of two parties and consequently produces the "wrong" answer.[13] Using the Lanchesterian approach, managers and onlookers derive comfort when they witness vast funds expended to acquire vast portfolios in highly prized categories.[14] Topology, however, may render much of these portfolios redundant, irrelevant to the particular competitor, negated by the competitor's holdings, or negated by the product's structure itself. To waste funds in this manner (funds which could have been more productively applied to R&D or business expansion), is especially dangerous in view of

11. For example, in chess, the Queen is conventionally associated with 9 points and a Rook with 5 points under the chess piece relative value system. But these "points" are mere reference tools for decision making and do not, in fact, reflect the actual merits of two players' positions.

12. The author solicited informal opinions from various colleagues at the September 18, 2018 "Business of Responsible Deal Making - Patent Licensing" IAM event in San Francisco regarding topological analysis. *Every* respondent affirmed that if topology were considered (and often it was not, certainly not in the licensing division), it would be *at the time of a licensing discussion*, rather than during prosecution management, and even then, at a generally anecdotal level. Indeed, as a negotiating tactic, each party to a licensing discussion may only seek an analysis insofar as it justifies that party's preferred valuation. While that may be prudent as a bargaining tactic, for purposes of internal strategy and prosecution management, this paper argues for a more objective parity-based approach.

13. The general nature of the error is as discussed in the chess example above, but more contextual examples will be discussed in greater detail *infra* in Section I.C.

14. Just as naively, one would think a larger army or more powerful weapons alone suffices to ensure victory under the Lanchester equations. This is true often, but certainly not always.

litigation's increasingly consolidated R&D focus[15] and given increased activist investor scrutiny following the 2008 financial crisis.[16]

However, the Lanchesterian approach's greatest defect is not that it may produce wrong answers – economists readily acknowledge that "perfect" valuation of an asset is impossible[17] – but that it prevents *meaningful accountability*, both spatial and temporal, for strategic portfolio decisions. Spatially, managers prosecute patents without being able to rigorously articulate *why* those patents will provide value against a *specific* competitor.

15. James Bessen & Michael J. Meurer, *The Patent Litigation Explosion*, 45 LOY. U. CHI. L. J. 401, 429 (2013) ("We find that the more R&D a firm performs, the more likely it is to be sued.") This paper suggests that Bessen and Meurer's paper implies the need for more "quick and dirty" tools to assess portfolios creatively between widely disparate industries ‒ tools such as Rules Based Parity Analysis ("RBPA"), presented herein. As Bessen and Meurer note, "about a quarter of patent lawsuits occur between firms that are in different industries and are also 'technologically distant,' suggesting that ex ante licensing and avoidance of patent disputes are difficult." *Id.* Thus, much of the burden of patent disputes falls on defending firms. "This distinction is important because although the rate of litigation per patent among public firms as plaintiffs did not increase much from 1987 to 1999, the rate of litigation per R&D dollar among public firms as defendants increased 70% . . . [h]owever, this does not appear to be mainly the result of better dispute resolution among large firms through patent trading and "defensive" patenting. We find that the defendant's portfolio size has, at best, only a limited effect on the probability of litigation, mainly among technologically close firms. *Any optimism that 'defensive' patenting might serve to reduce the growth of litigation is probably misplaced*" *Id.* (emphasis added). Bessen and Meurer frequently implicitly recognize the effect of topology in their research, e.g.: "At first glance, the idea of diminishing returns to patent portfolio size may seem counterintuitive. After all, if two firms merge, pooling their patent portfolios, why should this affect the rate of litigation per patent? But such a merger would affect the probability of winning a suit against a third firm—the probability of winning a suit will typically not double." *Id.* at 426.

16. Since the 2008 financial crisis, activist investors have aggressively sought creative methods to reacquire lost value. *See*, *e.g.*, Matteo Tonello, *The Activism of Carl Icahn and Bill Ackman*, HARV. L. SCH. F. ON CORP. GOVERNANCE & FIN. REG. (May 29, 2014), https://corpgov.law.harvard.edu/2014/05/29/the-activism-of-carl-icahn-and-bill-ackman/. ("In 2008, Icahn changed his tactics . . . . The acquisition was spurred in part by Icahn who, in July of that year, had encouraged Motorola to sell its lucrative portfolio of mobile phone patents.") *Id.* These pressures, and relational patent value, are especially apparent in the rivalry between DowDuPont and Bayer-Monsanto, each of which have undergone recent mergers and changes in structure while simultaneously seeking an edge in various technologies, such as CRISPR/Cas9 applications; *See, e.g.*, *Broad Institute and DowDuPont grant CRISPR agriculture licence*, LIFE SCIENCES INTELLECTUAL PROPERTY REVIEW (Aug. 08, 2018), https://www.lifesciencesipreview.com/news/broad-institute-and-dowdupont-grant-crispr-agriculture-licence-3043; *But see*, *Bayer and CRISPR Therapeutics AG join Forces to Discover, Develop and Commercialize Potential Cures for Serious Genetic Diseases*, CRISPR THERAPEUTICS (Dec. 21, 2015), http://ir.crisprtx.com/news-releases/news-release-details/bayer-and-crispr-therapeutics-ag-join-forces-discover-develop; *See also*, *CRISPR Patent Analytics*, IPSTUDIES (2019), https://www.ipstudies.ch/crispr-patent-analytics/; *Myths and Realities on DuPont CRISPR Assets*, IPSTUDIES (Feb. 16, 2018), https://www.ipstudies.ch/2018/02/myths-and-realities-on-dupont-crispr-assets/).

17. *See, e.g.*, Fischer Black & Myron Scholes, *The Pricing of Options and Corporate Liabilities*, 81 J. POL. ECON. 637, 637–54 (1973) in reference to the pricing of options. Obviously, a model employing a foundational assumption of Brownian motion cannot exactly reflect the behavior of an option's value, and yet the correspondence is sufficient that the "Black-Scholes" model has provided a paradigm-shifting tool for analysis.

Additionally, by applying "categorization and ranking" the analyst segregates the legal validity assessment from the marketing and engineering assessments. This segregation forces each group to operate upon the findings of the other independently. This often precipitates an unnecessary rivalry, wherein each group fails to recognize the overlap between its interests and its peers.[18] Temporally, when managers leave positions, their successors are often left with no thorough blueprint of the portfolio's strategy concerning a competitor (often because there was none) save the crude Lanchesterian representation of parity.

Consequently, this paper suggests one example framework for monitoring topological progress of peer portfolios, referred to herein as "Rules Based Parity Analysis ("RBPA")."[19] RBPA incorporates topology to ascertain parity between portfolios, but also provides a more granular framework for understanding *where* and *why* value is (or is not) derived from a portfolio as a consequence of topology.

This paper is organized as follows: Section I provides the conceptual framework and considerations motivating RBPA's form. Readers infrequently engaged in patent prosecution and licensing are encouraged to read Section I thoroughly. Readers familiar with patent strategy may safely skim Section I.A, but are encouraged to review Sections I.B and I.C (particularly in relation to FIG. 1). Section II then derives RBPA and provides an example RBPA calculator. Section III then addresses various legal doctrinal and practical matters influencing when and how RBPA may be applied.

18. Indeed, RBPA also begins with asset categorization, but this is simply the first step. Each subsequent step facilitates the participation of these other team members.

19. Not unlike how Feynman diagrams facilitate intuitive representations of more rigorous quantitative methods, Rules Based Parity Analysis ("RBPA") better informs practitioners of the topological character of their portfolio, providing a qualitative and, if desired, a greater quantitative understanding. Unlike the Lanchesterian approach, RBPA can pose and answer the following: 1) Are we behind our competitor? 2) If we are behind, how and why are we behind? And 3) What can be done about it? While the Author hopes RBPA will assist practitioners, the methodology also has value to scientific researchers, corporate R&D managers, stock analysts, corporate investors, and corporate officers, each of whom may prefer an intuitive visualization of a portfolio's position and relative strength as to a competitor.

I. TOPOLOGICAL ANALYSIS OVERVIEW

A. Exclusionary Rights and Valuation Factors

A patent is an exclusionary right.[20] Accordingly, to a first order, patents have no intrinsic value.[21] Rather, the patent's value is its ability to exclude *others* to *change* the *preexisting* value relations in favor of the patent's owner.[22] It cannot be emphasized enough that a patent, and consequently a portfolio's, true value is thus *relational* in its character. These value relations are themselves dictated by interactions between four topological factors: the (a) application of market demand to (b) business topologies (the manner in which a business is organized), (c) product/process topologies (the physical character of a product or process), and (d) claim topologies (benefits and restrictions imposed by various patents). Generally, these factors' relationships are as shown in FIG. 1. To reiterate, this is a diagram of the factors affecting a *patent claim's displacement value* (the presence of "claim topology" indicating that patents can themselves affect displacement value, a concept addressed more thoroughly in the next section).

20. From this simple fact, the relation to real property, from which value may be *independently* derived (by farming, construction, etc.), is already thrown into question.

21. True, to a second order, one could argue that patents do have *some* "intrinsic" value. For example, an employee who files and assigns a patent to her employer is much less likely to attempt to practice that patent at a subsequent place of employment. Similarly, the future may be so uncertain that having *any* asset can provide some comfort that the future may be prosperous. In this sense, patents are somewhat akin to real options. But these second-order considerations are not the primary factors for patent valuation (indeed, they each extend from a predicted exclusionary opportunity). Nor are they the primary factors of portfolio management. A young startup's choices may be simple: patent the technology you are developing (usually with only a handful of patents). But as a company and its portfolio mature, growing to dozens, hundreds, or thousands of technologies and patents, hard choices must be made. Where should we devote our R&D for greatest returns? How much should we devote? And when criticized by shareholders, what justification will we offer for doing so?

22. See *supra* note 15, for discussion of Bessen & Meurer.

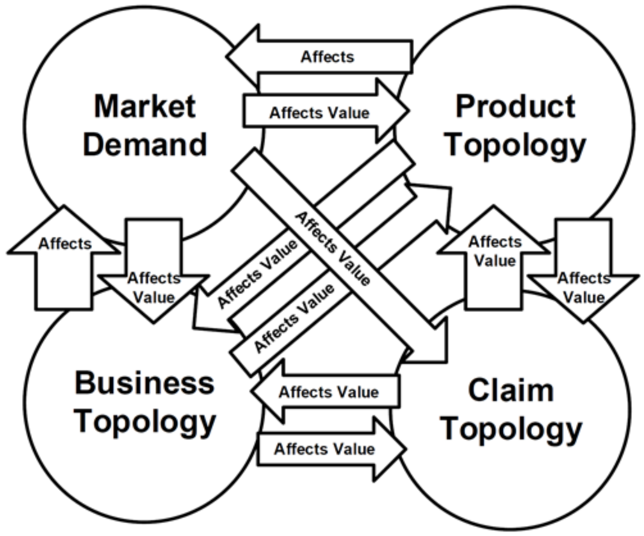

FIG. 1: Conceptual Topology Dependency Relations

The topologies often affect the claim displacement value of one another, for example, as when claims precipitate monopoly power for a business topology, product technical factors nullifying business structures, etc. Note that business and product topologies *can* affect demand (e.g., product development, as when Apple Inc.'s iPhone™ changes market demand for preceding phones), though this is often only the case in certain heavily consumer-facing technologies.[23]

To be concrete and to address, by way of example, each of these factors, in turn, consider two competing firms, Firm A and Firm B, in a hypothetical horse and buggy "market space" as shown in FIG. 2. We will discuss each of (a) market demand, (b) business topologies, and (c) product/process topologies in this Section I.A, while also introducing (d) claim topologies in this Section I.A, before discussing claim topologies more thoroughly in the following Section I.B.

23. For example, any market where the producer has the ability to create the illusion of scarcity may facilitate a change in market demand based on business topology factors or product topology factors. While claim topologies generally do not influence market demand, one can imagine a possible edge-case, e.g., a situation where advertising a product's patented status might encourage additional purchases.

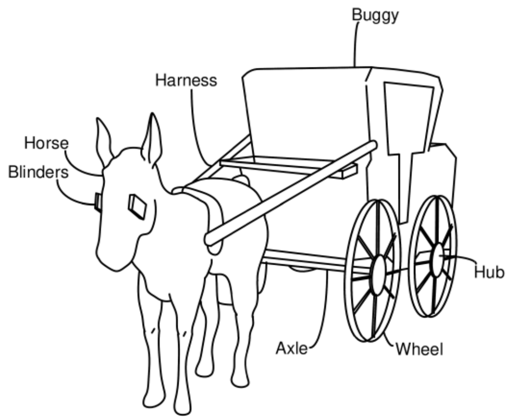

FIG. 2: Hypothetical "Horse and Buggy" Market Space

A "market space" is simply a systems-level characterization of a product or process, which includes a collection of interrelated components (the buggy's wheels, its axles, the driving animal, such as a horse, etc.), or steps in a process, chosen for their ability to adequately capture all factors *significantly* affecting the product or process's monetization for Firm A or Firm B concerning their respective patent portfolios. Despite this simplicity, as will be discussed in greater detail below, the systems-level selection of elements should be approached with care.[24]

1. Market Demand Example

Patent displacement value relations in the horse and buggy market space stem initially from the first factor: (a) market demand. If there is no present or future (a) market demand for horses and buggies (e.g., everyone prefers to drive automobiles), then any exclusionary right acquired in the space is *without value*. In other words, with nothing to displace, a patent's displacement value, in the hands of either Firm A or Firm B, is zero, absent demand. This is a simple point, but often overlooked by valuators.[25]

24. Defining the market space itself helps exclude considerations which are irrelevant to the patents at issue. For example, the road upon which the buggy travels and the driver are not included in the above example, since they are not considered germane to the analysis for Firm A and Firm B. Whether such exclusion is appropriate will depend upon the nature of the parties' business and the scope of their market exposure concerning the patent portfolios being considered.

25. The Author has had many discussions with investors of young companies who reason, to paraphrase: "If the company fails, we'll just sell the patents to recoup some of our losses." This reasoning assumes that there will be a buyer for the patents. Accordingly, the investor should *also* identify,

2. Business Topology Example

Similarly, let us now assume that there is a general market demand for buggies and consider the second factor, (b) business topologies, which involves each firm's structure and access to materials. Let us say that buggies may be made from oak or from mahogany.[26] Let us further say that Firm A's business connections *already* provide "artificial" monopoly control (e.g., in view of a deal with various governments) over all mahogany forests in the world. It follows that as Firm A *already* has a monopoly on mahogany buggies, Firm A's additional ownership of a patent on mahogany buggies effects no displacement. Consequently, given only these factors, such a patent has zero value to Firm A.

In contrast, in this situation, a mahogany buggy patent may have considerable value in the hands of Firm B, as the patent would then provide leverage (i.e., displacement from the status quo) against Firm A (returning mahogany forests to a duopoly between Firm A and Firm B). Note that in this situation, a patent on oak buggies would have value to both parties *assuming* they both wish to produce oak buggies and there exists market demand for oak buggies. Thus, to reiterate, and as will be emphasized in greater detail below, a patent's *value to its owner* is based upon *the posture of its competitor*, *not* simply the posture of the owner.[27] This is a frequently mistaken assumption of the Lanchesterian approach, wherein A's patent ownership in a market in which A is heavily invested is often *assumed* to provide value to A. Such an assumption can only be verified by considering A's *competitors* in that market.[28]

encourage the creation of, or *themselves create*, a topology amenable to a potential buyer if they intend the patents to serve as insurance for such an outcome.

26. These illustrations are chosen for conceptual rather than physical relevance. The Author has never attempted to manufacture a buggy and confesses a general ignorance as to the relative merits of oxen versus horses for personal transport.

27. While MURPHY, *supra* note 7, is an excellent book, this is one of the greatest criticism the Author has of it and similar titles, as well as of *many* economic papers concerning patents. In these treatises, patents are treated like real property or real options. However, there exists a *market for real property and real options in themselves.* In contrast, there *may* be a market for the product/process underlying a patent, but as IPXI will attest, there is, generally speaking, *no such thing as a market for patents*. To examine the patent and the market is only the *beginning* of the analysis, <u>not</u> the *conclusion*, which involves considering the patent with reference to the topology of a *specific* market participant. Indeed, the conclusion is so vital, it is probably worth beginning with entrant identification (an assessment of the competitor/acquirer) *before* even pursuing any formal valuation. Doing so may arguably result in considerable cost savings to the analyst (in short, no competing entrants equals no value, regardless of what the market may say).

28. Certainly, duopoly and oligopoly analysis consider the effects of other entrants. But an economist's recognition of price point variation is rarely commensurate with a portfolio manager's appreciation of value. This is, again, a common misunderstanding associated with the Lanchesterian analysis.

3. Product Topology Example

Concerning the third factor, (c) product (or process) topologies, we consider how the physical nature of the product (or process) influences value. Again, consider competing firms, Firm A and Firm B, imagining that Firm A has a foundational patent on the use of horses with buggies, i.e., a patent with claims on the use of horses with buggies. If buggies are only physically capable of being pulled by horses, then the patent may have considerable value, as it will displace Firm B entirely, again assuming there remains market demand for buggies generally. However, if buggies may be drawn by horses or by oxen, i.e., a substitute exists, then the value of the horse patent will be diminished in proportion to the degree of possible substitution, but *only* to the extent such substitution is available to Firm B's manufacturing process. Thus, it is not simply the cross-price elasticity in a question of the market, *but Firm B's ability to avail itself of the substitute*, which dictates displacement value.

4. Practice and Royalty Value

Note that changes in both (b) business and (c) product topologies may have "unilateral" and "bilateral" relations between, and within, themselves. These relations may be represented by a "dependence network." For example, consider the above hypothetical wherein Firm A possessed an artificial monopoly on mahogany buggies via its control of mahogany forests. Additionally, assume that, in the entire world, only one saw mill, Saw Mill O, is, and can be, adequately equipped to process oak for buggy production and only one saw mill, Saw Mill M, is, and can be, adequately equipped to process mahogany for buggy production, each saw mill presently owned by a disinterested third party. If given the option to purchase only one mill, should Firm B (the firm competing with Firm A's preexisting mahogany monopoly) purchase Saw Mill O or Saw Mill M? The answer will depend upon how much value is afforded to Firm B by monopoly control of oak processing as compared to returning mahogany to a duopoly with Firm A. This dependence network and the two choices can be visualized as shown in FIG. 3.

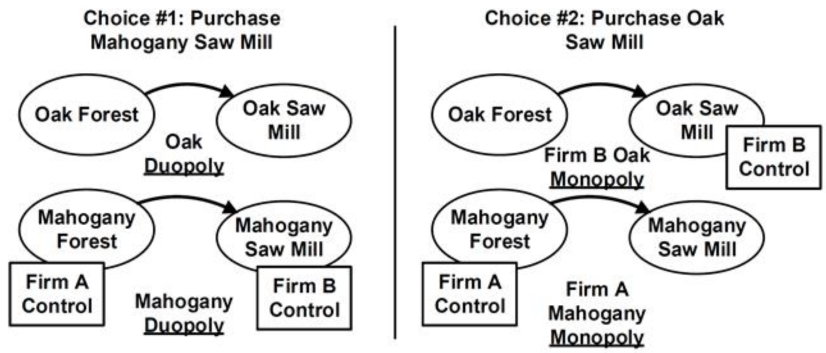

FIG. 3: Dependencies and Saw Mill Purchase Choices

Here, the arrow from a forest to the mill illustrates that the value of the forest depends upon the value of the mill (a "unilateral" dependence). If a mill were *only* capable of processing oak or mahogany, then the dependence would be "bilateral," since the mill would be useless without access to the forest and an arrow should be drawn from the mill to the forest.

As demonstrated by this example, topological changes in the presence of dependence may radically alter the value a firm derives from an asset precipitating monopoly (whether it be a mahogany forest *or a patent*). That is, Firm B's unilateral purchase of the Mahogany Saw Mill M has potentially more than halved Firm A's monopoly value in the mahogany forest. Furthermore, appreciate that where these changes impact asset control, they affect value via two facets: 1) Firm A's ability to leverage monopoly profits using the mahogany forest; and 2) Firm A's ability to license that monopoly right to others. The former facet is referred to herein as the "practice value" and the latter facet as the "royalty value" of the monopoly right. Topology changes may affect both the practice and royalty value, only one, or neither.[29]

As explicitly referenced in the preceding paragraph, these two channels, practice value and royalty value, are especially important for the final topological factor, (d) claim topology, which, naturally, is of particular importance to the portfolio manager. Patent claims can displace value in both

29. Many existing methodologies do consider both product and royalty value, but often by assuming the existence of some fictional all-inclusive market. To assert that "X paid R for Y's patent in 2008, therefore Z should pay ~R in 2009" entirely ignores the underlying topologies of each situation. Instead, an analyst considering historical "comparable exchanges" and "comparable transactions" must also carefully consider what it means to be "comparable" in connection with topology in the first place (*See, e.g.*, MURPHY, *supra* note 7, at 189–216 discussing "Market Methods" acknowledging that "[a]ctive, competitive markets have proven difficult to assemble for patents" and encouraging the reader to recognize limitations to market-based valuation.

the (b) product topology and (c) business topology. But just as in the saw mill hypothetical, patent claims may *also* displace patent claims (just as Firm B's monopoly saw mill acquisition–analogous to Firm B's acquiring a second patent–affected Firm A's monopoly on Mahogany forests–analogous to a preexisting first patent owned by Firm A).

Particularly, imagine that there is market demand for buggies and that Firm A has a foundational patent on the buggy concept itself. Firm B may file patents upon improvements to aspects of the buggy system–improvements to the wheels, to the blinders, to the axle, etc. but it does so under the penumbra of Firm A's initial, comprehensive, foundational filing.

Thus, however beneficial Firm B's improvements may be, they remain subject to royalty stacking in view of Firm A's patent.[30] Note that the relation may be bilateral in some instances. For example, the value of practicing the foundational patent in the marketplace may now depend upon including these improvements, a form of "reverse royalty stacking."[31] Indeed, in the extreme case, the doctrine of equivalents may not extend to the improvement, thereby possibly creating a substitute to the foundational patent via the improvement–turning the tables and *displacing the foundational patent* entirely![32]

As evidenced by the above hypotheticals, the patent value cannot be considered by any one of (a), (b), (c), and (d) in isolation. That oxen is a substitute in (c) only diminishes the patent's (d) value *if* oxen are available to *B* (b) and *if* there is market demand for oxen-pulled buggies (a). Having located patent value in the exclusionary displacement effected by the combination of (a), (b), and (c), and (d) topologies on a *specific* entity, we must next more specifically consider how a plurality of patent rights (i.e., a portfolio) operate in relation to this displacement.

30. This is especially an issue in Standards Setting Organizations ("SSOs") and in nascent technologies, such as, e.g., CRISPR/Cas, where ongoing research and development has the ability to qualify or negate the leverage of previous patents. Conversely, legacy patents may acquire new leverage where market participants encourage future development within their scope. *See e.g.*, James Skelley, *Coordinating the Offshore Energy Transition: A Legal Economic Framework*, 23 B.U. J. SCI. & TECH. L. 241, 276–85 (2017) (for a discussion regarding leverage within SSOs).

31. This is a term coined by the Author, but a phenomenon recognized by other practitioners.

32. This behavior may be especially prevalent in early-stage technologies where the status and relational character of foundational patents are still uncertain. *See, e.g.*, Regents of the Univ. of Cal. v. Broad Inst., Inc., 903 F.3d 1286, 1296–97 (Fed. Cir. 2018) ("We note that this case is about the scope of two sets of applied-for claims, and whether those claims are patentably distinct. It is not a ruling on the validity of either set of claims."). This case, with its many possible future directions in research and business development, provides a fine opportunity to apply the Monte Carlo methods discussed *infra* Section III.B, especially as the patent's validity has yet to be litigated. Regarding the doctrine generally, *see* Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 520 U.S. 17 (1997).

B. The Claim Topology Factor and Lanchesterian Pitfalls

As discussed in the footnote above, some portfolio managers pursuing the Lanchesterian approach may actually appreciate the relevance of topological considerations, but may consider those factors too complicated for introduction into their analysis [33] This section suggests that this misperception may have arisen from the practitioner's conflating a patent's claim scope with its displacement value, or alternatively, the practitioner's assuming that the separation of the two would complicate, rather than simplify, their analysis.[34] Accordingly, this section explains why scope and value must be separated to adequately capture the claim topology factor's relation to the other topological factors. Since RBPA builds upon this separation, this section, like the previous, lays the groundwork for RBPA's derivation.

Patent rights are defined by "claims," each of which is a sentence, the sentence itself comprising a number of elements. A claim thus defines a "sub universe" within the universe. For example, the claim "A buggy comprising a steel frame and a hull, wherein the hull is fiberglass, and wherein the fiberglass *is blue*" is a sentence directed to a "buggy" having two elements, a frame and a hull. Elements may be further limited, and those limitations limited, *ad infimum,* as evidenced here by the recitation that the frame is "steel" and the hull is "fiberglass" the fiberglass itself being "blue."

To infringe a claim, one must practice *all* the elements in their limited form.[35] For example, a buggy which has "a steel frame and a hull, wherein the hull is fiberglass, and where the fiberglass *is red*" would fail to meet the "hull" element, since the hull is red, rather than blue, as required by the claim.[36] Thus, infringement analysis, as an exercise in natural language understanding, closely resembles set theory. For example, one can visually depict the above infringement analysis as shown in FIG. 4.

33. *See, e.g.*, MURPHY, *supra* note 7, at 8. ("By their very nature, patents can pose particular information input challenges for valuators . . . [t]hese challenges are compounded by the unique nature of patents and the lack of robust patent trading markets. As a result, patent valuation can be more weighted toward the art, rather than the science, side of the spectrum."). RBPA, while still requiring the inclusion of context-specific information, is meant to standardize and thereby reduce this valuation ambiguity. If negotiators can agree on the relevant market space and the relevant rules (admittedly, a nontrivial achievement in itself), then valuation should fall out mechanically.

34. Indeed, this has often complicated the Author's own analysis in the past.

35. *See, e.g.*, Lemelson v. United States, 752 F.2d 1538, 1551 (Fed. Cir. 1985) ("It is . . . well settled that each element of a claim is material and essential, and that in order for a court to find infringement, the plaintiff must show the presence of every element . . . in the accused device.").

36. As is typical of any exercise in natural language understanding, ambiguity, within bounds, permeates the scope of the claim.

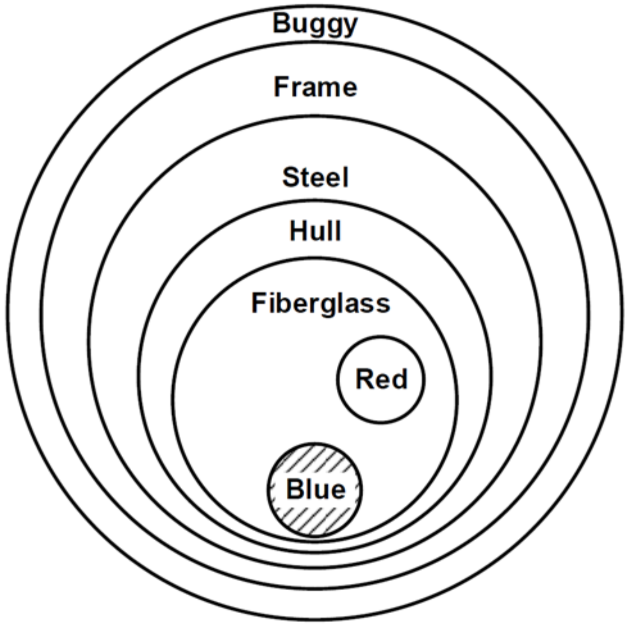

FIG. 4: Visualization of Example Buggy Claim

One can read this diagram as follows: In the universe of buggies, most have frames and some do not. In those with frames, some are steel and some are not. Of those having steel, some also have hulls, and some do not. In those with hulls, etc. Again, the claim, with its elements and limitations, identifies a subset of the universe of products which infringe. Since a red fiberglass hull falls outside this subset, it does not infringe. Note that while a "frame" and a "hull" are *separate* elements, as claim conditions they together serve to restrict the universe of infringement. Consequently, while FIG. 2 limits the universe first by hulls, then by frames, an alternative representation showing limitation by frames then by hulls would still depict the same sub universe.[37]

37. *See generally*, Phillips v. AWH Corp., 415 F.3d 1303 (Fed. Cir. 2005) for a discussion of claim construction. Recently, the Patent Trial and Appeal Board ("PTAB") abandoned the "Broadest Reasonable Interpretation" standard of claim construction in favor of the *Phillips* approach. *See* Changes to the Claim Construction Standard for Interpreting Claims in Trial Proceedings Before the Patent Trial and Appeal Board, 83 Fed. Reg. at 51340 (Oct. 11 2018). This consistency simplifies the application of RBPA as (to a first order) any rules or probabilities in connection with claim interpretation at the district court may be (substantially) subsumed with analysis at the PTAB. Of course, only certain points of invalidity may be considered at the PTAB as compared to the district court. Consequently, rules of the former may be simply a subset of rules for the latter.

Naturally, dependent claims, by adding additional elements will form further sub-sub-universes as shown in FIG. 5, where S_1 is the sub-universe of the parent claim (e.g., all the limitations of FIG. 4 as represented by the shaded circle labeled "Blue") and S_2 is the sub-sub-universe of the dependent claim (e.g., all the limitations of FIG. 4 plus one or more additional limitations, e.g., "wherein *only two sides* of the buggy are blue").

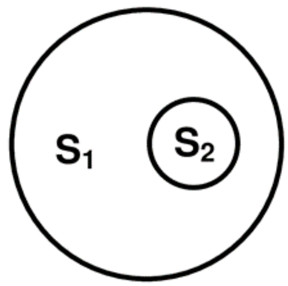

FIG. 5: Subsets

The Lanchesterian practitioner may argue that claim dependence under the above infringement analysis is coeval with claim topological displacement dependence in the (b) product, (c) business, and claim (d) topological spaces. After all, doesn't the double patenting requirement mandate that no two assets have identical claims?[38]

But infringement and displacement analysis are not coeval, as the query "does a red buggy infringe this claim?" is a very different query from "does this first patent's claim on a red buggy influence the value of this second patent's claim on a blue buggy?"[39] Both analyses involve set relations and sub-universes, but the former occurs in a *space of definitions* whereas the latter occurs in the *space of value displacement*, i.e., the topological space. Thus, the practitioner is correct only insofar as "infringement" dependence between two separately owned claims is often a stronger statement, in the logical sense than topological dependence. That is, if infringing Claim A,

38. *See, e.g.*, MANUAL OF PATENT EXAMINING PROCEDURE § 804 (9th ed., rev. 2018) ("There are generally two types of double patenting rejections. One is the 'same invention' type double patenting rejection based on 35 U.S.C. § 101 which states in the singular that an inventor 'may obtain a patent.' The second is the 'nonstatutory-type' double patenting rejection based on a judicially created doctrine grounded in public policy and which is primarily intended to prevent prolongation of the patent term by prohibiting claims in a second patent not patentably distinct from claims in a first patent.")

39. For example, double patenting may prevent identical coverage *in the infringement context*, but it certainly does not prevent identical coverage *in the topological context*.

owned by Party A, necessarily infringes Claim B, owned by Party B, then Claim A must necessarily topologically depend upon Claim B, but the reverse is not necessarily true.[40] Since, as indicated in Section I, value lies in the topological displacement, we must speak only of topological rather than infringement dependence when considering value since the two are *not* coeval as asserted by the Lanchesterian analysis.[41]

The necessity of discussing topological displacement is further reflected in a common error of the Lanchesterian approach: double counting. By assuming that infringement displacement is coeval with topological displacement, and then observing that infringement displacement is independent as a consequence of the double patenting prohibition, the Lanchesterian approach mistakenly concludes that each asset's *value is independent*.[42] For example, a Lanchesterian portfolio manager may advise her company as follows: "We have a portfolio A of N high-quality claims evenly divided among seven product categories and our competitor has a portfolio B of N high-quality claims evenly divided across those same categories. *Consequently, our positions are roughly equivalent*."

This practitioner's reasoning is faulty because she equates the number of independent claim sub-universes with the number of independent competitor topological displacements. Specifically, she assumes the value of a portfolio is the *sum* of its coverage, when in fact, it is the *union* of its coverage within the space of topological displacement. Consider the overlapping sets of FIG. 6.

40. For intuition, here is this sentence again with an example: If infringing Claim A (the claim represented by S_2 of FIG. 5, again, depicting the infringement space), owned by Party A, necessarily infringes Claim B (the claim represented by S_1 of FIG. 5, which must be the case, since, as a subset of Claim B, Claim A meets all the limitations of Claim B), owned by Party B, then Claim A (again S_2 of FIG. 5) must necessarily topologically depend upon Claim B (e.g., one cannot take a license to Claim A from Party A or practice that invention without *also* taking a license to Claim B from Party B), but the reverse is not necessarily true (e.g., it may be possible to practice in the region S_1 without practicing in S_2 as when one implements a horse and buggy without the improvement of S_2).

41. So subtle is the transition, that practitioners will often speak of them interchangeably without being aware that they are doing so. Inherent vagueness of language also complicates rigorous distinctions. For example, one may casually say "Firm B's claim B to their improved axle depends upon Firm A's foundational claim A on the buggy system" without realizing the multiplicity of possible meanings. Is the speaker saying that infringing claim B necessarily infringes claim A (the "infringement" dependence)? Or are they instead saying that as a practical matter, the axle of claim B has no useful application unless appearing in a system covered by claim A (the "topological" dependence) and consequently subject to royalty stacking? Or is the dependence only a partial topological dependence and the axle of claim B may be used in, e.g., automobiles rather than buggies, without infringing claim B?

42. Just as Lanchester assumed that each fighting unit was independent.

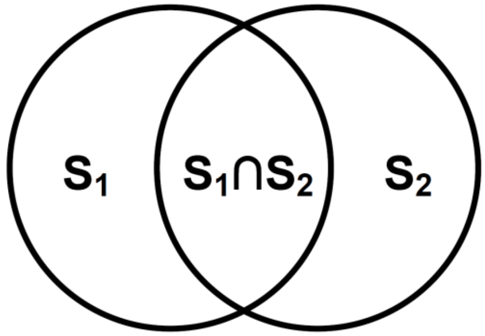

FIG. 6: Overlapping Sets

As discussed above, it is the *exclusionary topological displacement* that affects value, which is represented in the cumulative *union* of the claim effects. This is true for both practice value and royalty value. The union is *not S_1 plus S_2* as asserted by the Lanchesterian approach, as this would double count the region $S_1 \cap S_2$, referred to mathematically as the intersection of S_1 and S_2. In mathematical terms, the union $S_1 \cup S_2$ is instead properly reflected by the following equation:

$$S_1 \cup S_2 = S_1 + S_2 - S_1 \cap S_2 \quad (4)$$

which removes an instance of the double-counted intersection.

The Lanchesterian practitioner may respond that she appreciates this pitfall and has accounted for it by lumping all claim sets of the type found in FIG. 5 into a single entity (i.e., treating of S_1 and S_2 in FIG. 5, when co-owned by the same entity, as S_1 simply), and that since claims may not be for the same universe, i.e., are independent in accordance with the requirements of double patenting, what remains are disjoint sets, and being disjoint, the union is indeed their sum.[43] To reiterate, this would be sufficient if the infringement scope were coeval with displacement value, but as discussed above, this is not the case.[44] Improved blinders have little value

43. Incidentally, to be thorough, appreciate that it *is* possible, in theory, to have two patents claiming overlapping ranges, which do not run afoul of double patenting (*See, e.g.*, MPEP § 2144 regarding nonobvious overlapping ranges in conjunction with "obviousness-type" double patenting in MPEP § 804). Consequently, the claims *will* overlap in the infringement space as well. However, this is an outlying case, and even for this case, it is topological, not infringement, displacement affecting value.

44. Technically, to be comprehensive, it wouldn't even always be true then. Consider, e.g., a first claim "wherein the hull has a length of between 2 and 4 meters" and a second patent with a claim "wherein the hull has a length of between 3 and 10 meters." In this situation, buggies with hulls of lengths of 3–4 meters, meeting all the other limitations, would infringe both claims. Here, the infringement dependence

without a horse to put them on. Considering component benefits independently, without considering their topological overlap, misrepresents their true value, whether it be more or less than their assumed independent sum.

It is at this point that the Lanchesterian practitioner may concede the necessity of topological dependence in their analysis, as well as the need for an accurate assessment of union coverage. However, the practitioner may now protest that such a granular, topological assessment is simply impractical. For example, consider the exclusionary displacement valuation determination for *only three* claims as shown in FIG. 7.

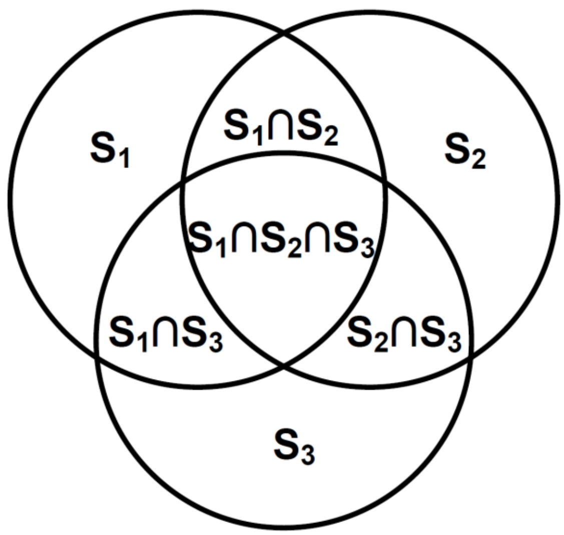

FIG. 7: Three claim assessment

Performing the additions and subtractions of Equation 4, or alternatively assessing each universe in isolation, to determine the union may be impractical. For the latter, to properly assess the value of their union, we must determine the displacement effect of each claim *only* in isolation (S1, S2, S3), the combined *and only* the combined effect (S1 ∩ S2, S1 ∩ S3, S2 ∩ S3), and then the entire combination *and only* the entire combination (S1 ∩ S2 ∩ S3). For N sets, this results in the generation of 2^N-1 displaced universes that must be separately and independently considered (e.g., there are 3 sets

is limited and the topological displacement of losing 4-100 meters of design flexibility is much more significant.

above and therefore 2^3-1=7 separate universes at issue). A patent portfolio may have hundreds of patents, each with multiple claims. Indeed, a modest portfolio may comprise 20–30 independent claims and thereby precipitate 1,048,575 and 1,073,741,823 universes for individual consideration respectively. Even appreciating the need for topology, these numbers seem to have dissuaded practitioners from further topological analysis.[45]

It is worth remembering, however, that in chess there are over 9 million possible board configurations after only *three* moves.[46] Yet, this diversity has not prevented centuries of analysis nor diverted a profitable teaching and book market for chess instructors. In addition, as discussed above, value must be discussed in terms of topology and not in terms of claim sub-universes only. Consequently, so long as our analysis, as in chess, lends itself to the identification of recurrent patterns and motifs, we need not despair as to its utility. The answer, as we shall see in the next section, is to resolve this multiplicity of universes by eschewing the perspective of the *patents*, and instead adopting the perspective of the *products and processes* to which they apply.

C. Product Substitute Universes

Every product or process comprises a collection of contingent subunits, which may be represented via system diagrams.[47] For many products or processes, however, the structural dependencies between units can be quite complex. Changing even a single transistor in some complex communications devices can precipitate undesired consequences. However, despite the complexity of *operational* relations within these systems, to a first order, it is possible to classify components based upon their ability, perhaps limited, to support *substitutional* relations. This section will briefly explain how these relations may be represented before fully explaining their relevance to RBPA in the following section.

Again, consider the horse and buggy market space of FIG. 2. Given a market space comprehensively capturing the elements relevant to an inquiry concerning a given product or process value as between competitors, we can identify aspects of the system possessing substitutes (sometimes including

45. Indeed, the Author has never heard practitioners discussing portfolios in this manner, let alone pursuing the following discussions concerning product/process substitute component combinations.

46. There are over 288 billion after four (*See, e.g.*, David Fuhriman, *How Many Possible Move Combinations Are There in Chess?* BERNMEDICAL (Mar. 1, 2013), http://www.bernmedical.com/blog/how-many-possible-move-combinations-are-there-in-chess).

47. Though products are used in this example, a process may be analyzed *mutatis mutandis*, e.g., applying steps instead of components.

the null element). These relations may be represented in a Substitution Map ("SM"), which is a table, e.g., as shown in FIG. 8:

Substitute Class		
Blinders	$\text{Blinder}_{\text{Leather}}$	Ø (None)
Wheels	$\text{Wheel}_{\text{Wood}}$	
Carriage	$\text{Carriage}_{\text{Wood}}$	
Animal	Ox	Horse
Mirror	Mirror	Ø (None)

FIG. 8: Hypothetical Horse and Buggy Substitution Map

In this example, the analyst has decomposed the market space (FIG. 1) into five substitute classes ("Blinders," "Wheels," "Carriage," etc.), each of which may afford a different substitute (e.g., the blinders may be leather blinders, or blinders may not be used at all as represented by the null element). Selecting one substitute from each class creates a viable product/process (i.e., a "functional buggy"). For example, one may construct a buggy using a leather blinder ($\text{Blinder}_{\text{Leather}}$), wooden wheels ($\text{Wheel}_{\text{Wood}}$), a wood carriage ($\text{Carriage}_{\text{Wood}}$), a horse (Horse), and without a mirror (the null element, Ø (None)). The SM is thus a first step in capturing the (c) product topology.

The analyst selects the classes based upon the product topology so that the substitutes being physically disjoint options, are independent of one another in the value displacement they effect. Note, however, that while within-class substitutes are independent, substitutes between classes may NOT have value independence with substitutes of other classes. For example, while the SM indicates that a buggy may be pulled by an Ox or by a Horse, but not by both and by at least one, horses may require blinders but oxen may not.[48] Thus, inter-class dependencies are not yet reflected in the SM.

48. A Horse may be a normal horse or a horse bred for speed, but not both. Since only one of these three may be selected for the Animal class (there is no null element as *something* must be selected) it is appropriate to create our own map. However, horses may require blinders while oxen do not. Thus, if an ox is selected, one must always select the null option for blinders. These relationships will be reflected in the "product" rules, discussed *infra*. If a party could only source horses, this would be reflected in the party's "business" rules, discussed *infra*.

In Section I, we recognized that a modest portfolio may comprise 20–30 claims, precipitating 1,048,575 and 1,073,741,823 universes for individual consideration when determining the displacement union. Intuitively, one may have suspected that many of these universes are redundant or minimally distinct. This intuition is grounded in the fact that many substitutes are independent, e.g., one can assess the value add of an improved mirror without considering its use with oxen as opposed to horses. A substitution map, by introducing substitution independence, helps remove these minimally distinct universes from our analysis.

Particularly, we introduce patents into our analysis by considering them as qualifiers to substitute classes. Let us say, for example, that firm A has a patent "A1" on a "speed buggy," which to infringe, requires blinders designed for speed, a wheel designed for speed, and a horse bred for speed. Additionally, assume that Firm B has a patent "B1" on wheels with rubber lining and a patent "B2" on fiberglass carriages. Finally, assume that it is possible to design a wheel for speed with rubber lining. The map thus becomes as shown in FIG. 9.

Substitute Class				
Blinders	$\text{Blinder}_{\text{Leather}}$	$[\text{A1}_{1/3}]$ $\text{Blinder}_{\text{Speed}}$	Ø (None)	
Wheels	$\text{Wheel}_{\text{Wood}}$	$[\text{A1}_{2/3}]\text{Wheel}_{\text{Speed,Not Rubber}}$	$[\text{B1}]\text{Wheel}_{\text{Not Speed,Rubber}}$	$[\text{A1}_{2/3}][\text{B1}]$ $\text{Wheel}_{\text{Speed,Rubber}}$
Carriage	Wood	Fiberglass[B2]		
Animal	Ox	Horse	$[\text{A1}_{3/3}]\text{Horse}_{\text{Speed}}$	
Mirror	Mirror	Ø (None)		

FIG. 9: Substitution Map Updated with Patents

First, observe that because claim A1 requires a combination of substitutes across classes (e.g., its elements include items from different classes), its presence is reflected with a subscript indicating that infringement is *only* achieved by employing a particular combination of substitutes. In contrast, since B2 only needs to cover fiberglass hulls to infringe, the only patent qualifier designation is in the hull class (Fiberglass[B2]).

The specter of intersecting claim scope combinations discussed above with respect to FIG. 5 now only raises its head *within a substitution class* (i.e., within a row) as the map was designed such that classes are *substitutionally* independent (i.e., between rows). For example, when we assign patent qualifiers in the Wheels class (substitutes covered, in part, by A1 and those covered by B1), we consider whether substitutes in this class may infringe (at least in part) one or both patents. In this example, both assets apply to the "$\text{Wheel}_{\text{Speed,Rubber}}$" substitute, but only one asset applies to each of the $\text{Wheel}_{\text{Speed,Not Rubber}}$ and $\text{Wheel}_{\text{Not Speed, Rubber}}$ substitutes. Considering each patent asset in relation to a single substitute is a *much* more tractable query than trying to determine the effects of the 2^N-1 possible regions of N assets as discussed with respect to FIG. 7. The SM may be designed to avoid monolithic classes and thereby further simplify this assessment.[49]

An SM may be used to generate a "Substitute Design Universe," i.e., the collection of all possible products or processes produced by selecting one substitute item from each of the substitution classes. Each combination of substitutes is referred to herein as an "instance." Various sub-universes may be identified by excluding instances incorporating particular substitute items. Indeed, by applying patent qualifiers to substitute class items as in FIG. 9, we can readily determine the exclusionary effect of one or more assets on the Substitute Design Universe. This approach, as applied via RBPA, is discussed in greater detail in the following section.

II. THE PARITY EQUATION AND RULES-BASED ANALYSIS

A. The Parity Equation

We are now in a position to derive RBPA.[50] We proceed by first determining the "correct" measure of parity and then relaxing our requirements based upon the information available to the practitioner. Let us define "leverage" as a value between 0 and 1. A value of 0 indicates that one party's portfolio has absolutely no influence on the other party. That is, during negotiation, the portfolio, alone, can provide no encouragement for concessions from the other side. In contrast, a leverage value of 1 indicates that the other party cannot participate in the market space *at all*, as it had prior to the portfolio's presence, without first reaching an agreement with the portfolio owner. Naturally, leverage can be adjusted for both objective

49. As will be discussed, this need only be done with respect to the analysis target.

50. Research rivals rarely survive long without taking notice of one another. *See* Bessen & Meurer, *supra* note 15, at 429 ("Thus an important part of the burden of patent disputes falls on defending firms. This distinction is important because although the rate of litigation per patent among public firms as plaintiffs did not increase much from 1987 to 1999, the rate of litigation per R&D dollar among public firms as defendants increased 70%."). This, in combination with the above observations regarding exclusionary value, makes clear that the basic tool for the portfolio manager's analysis must reflect a *comparison with one's peer portfolios*. RBPA is designed for this purpose.

factors and subjective psychology–Don Quixote's valuation of windmill production may not be the same as that of General Electric. However, the proposed enumeration based on substitutes, discussed below, provides a generally objective foundation. For now, appreciate simply that leverage reflects the degree to which one party may exclude another from a market space.

"Parity" between two parties is then the perception of their relative leverage from the perspective of one of those parties. Particularly, Party A's parity as to Party B, may be represented in the following "parity equation:"

$$Parity(A, B) = Lev_{A \to B} - Lev_{B \to A} \tag{5}$$

where $Lev_{A \to B}$ is the portfolio value leverage of Firm A's portfolio *as to* Firm B and $Lev_{B \to A}$ is the portfolio value leverage of Firm B's portfolio *as to* Firm A. Thus, when neither party has a portfolio, $Parity(A, B)$ is zero ($Lev_{A \to B}$ and $Lev_{B \to A}$ are each zero).[51] Again, note as discussed above, that zero parity does not mean that the parties are equally situated – their business and product topologies may be very asymmetric – zero parity refers only to their patent portfolios' providing equal leverage. When the portfolios effect equal, but non-zero, leverage, $Parity(A, B)$ is again zero ($Lev_{A \to B}$ equals $Lev_{B \to A}$).[52] When Firm A's portfolio substantially dominates Firm B's, then $Parity(A, B)$ is 1 (e.g., $Lev_{A \to B}$ is 1 and $Lev_{B \to A}$ is 0). Conversely, when Firm B's portfolio substantially dominates Firm A's, then $Parity(A, B)$ is -1 (e.g., $Lev_{A \to B}$ is 0 and $Lev_{B \to A}$ is 1). Naturally, $Parity(B, A) = -Parity(A, B)$ *if* the same factors are considered, but if other factors, particularly subjective factors, are introduced, then the two may not be equal.[53]

What then is the proper measure of leverage, $Lev_{A \to B}$ and $Lev_{B \to A}$? As discussed above, a portfolio may effect leverage in two channels: practice value displacement and royalty value displacement (See Section I.A.4). Accordingly, we can combine and scale these proportionally as follows to ensure results between 0 and 1:

51. Again, parity is *only* a metric for *patent portfolio value*. One party may have substantially more market share than the other, but if neither has a portfolio, neither exerts any displacing effect on the other via their portfolios, and consequently, neither has any portfolio-based leverage. Consequently, each has a parity of zero relative to the other.

52. Consequently, each party's position depends only on preexisting factors (relative investment, relative teams, etc.).

53. A large negative value reflects Firm B's influence on Firm A and a large positive value Firm A's influence on Firm B.

$$Lev_{A \to B} = \frac{\Delta Val_{P,A \to B} + \Delta Val_{R,A \to B}}{Val_{P,B} + Val_{R,B}} \quad (6)$$

where $Val_{P,B}$ is the practice value of the entire SM design universe to *Party B prior* to restriction based upon *Party A*'s patents (sometimes referred to herein as the ex-ante value), $Val_{R,B}$ is the royalty value of the entire SM design universe to *Party B prior* to restriction based upon *Party A*'s patents, $\Delta Val_{P,A \to B}$ is the difference in practice value between $Val_{P,B}$ and the universe following restriction based upon Party A's portfolio $Val_{P,A \to B}$ (sometimes referred to herein as the ex post value), i.e.,

$$\Delta Val_{P,A \to B} = Val_{P,B} - Val_{P,A \to B} \quad (7)$$

Similarly, with respect to royalty value, $\Delta Val_{R,A \to B}$ is the difference in royalty value between $Val_{P,B}$ and the universe following restriction based upon Party A's portfolio $Val_{R,A \to B}$, i.e.,

$$\Delta Val_{R,A \to B} = Val_{R,B} - Val_{R,A \to B} \quad (8)$$

$Lev_{B \to A}$ is then the same, reversed *mutatis mutandis*.

Let us make two important observations regarding Equation 6 when introduced into Equation 5. First, Equation 6 scales each Party's leverage in the event valuation displacement is not felt evenly by the parties. For example, if Party A receives $100,000 in practice and royalty profits, but Party B receives $10M for the same, a $90,000 displacement is assumed to effect greater leverage in the former than the latter.[54] Thus, the equations assume that leverage is proportional to the effect on market presence.[55] If this is not true (e.g., Party A is indifferent to bankruptcy), the practitioner will need to introduce scaling factors to account for the subjective differences.

Second, note that Equation 6 combines the practice value and royalty value channels into a single number. Such a combination may be suitable when $Val_{P,B}$ and $Val_{R,B}$ are known with some precision. When they are not, the analyst may prefer to consider them separately, assessing parity for

54. Typically, portfolio managers will wish to assess portfolio leverage independently from other factors, such as market share, since the other factors are beyond the manager's responsibility or influence. Consequently, the manager will typically scale or normalize the differences as shown in Equation 6. Some, more expansive investigations, however, may consider each party's position from a more absolute perspective, without such scaling.

55. This is often a good assumption, but again, one must consider subjective and other factors unique to the circumstances under consideration.

practice and royalty value separately, in which case the practice value leverage exclusively is simply

$$Lev_{(Practice\ only),A\to B} = \frac{\Delta Val_{P,A\to B}}{Val_{P,B}} \qquad (9)$$

and the royalty value leverage is simply

$$Lev_{(Royalty\ only),A\to B} = \frac{\Delta Val_{R,A\to B}}{Val_{R,B}} \qquad (10)$$

Each of $Lev_{(Practice\ only),A\to B}$ and $Lev_{(Royalty\ only),A\to B}$ can then be introduced into Equation 5 independently, to determine parity as to practice and royalty value separately.

How do we determine each of $Val_{P,B}$, $Val_{P,A\to B}$, $Val_{R,B}$, $Val_{R,A\to B}$? This is the subject of Section II.B.

B. Substitute Combinations for Practice and Royalty Value

Let us first consider practice value (as the calculation for royalty value is analogous). To reiterate, $Val_{P,B}$ is the *value* of the entire SM universe to Party B *prior* to restriction based upon any of Party A's patents. $Val_{P,A\to B}$ is then the *value* to Party B following such restriction. Let us therefore define a function, $Univ\ Val_{P,B}$ which accepts a universe of available design choices as argument and outputs the value of that universe to Party B. Thus, when the function is applied to an unrestricted design universe *U* from a Substitute Map, the value is $Val_{P,B}$:

$$Val_{P,B} = Univ\ Val_{P,B}\ (U) \qquad (11)$$

Similarly, we can use this function to determine the value of the universe restricted by Party A's patents $U_{Sub\_A\_Patents}$ and the resulting difference:

$$\Delta Val_{P,B} = Val_{P,B} - Univ\ Val_{P,B}\ (U_{Sub\_A\_Patents}) \qquad (12)$$

How are we to determine this function, and by implication, how are we to represent each universe? As discussed above, in Section I.C with respect to the SM of FIG. 9, we can represent a design universe as a vector filled with each instance created from a combination of the M possible substitute combinations in the SM, i.e.:

$$U = \begin{bmatrix} \text{Blinder}_{Leather}, \text{Wheel}_{Wood}, \ . \ . \ . \\ \text{Blinder}_{Leather}, \text{Wheel}_{Wood}, \ . \ . \ . \\ \vdots \\ \text{Ø(None)}, \text{Wheel}_{Speed,Rubber}, \ . \ . \ . \end{bmatrix} \tag{13}$$

That is, we create the first "instance" entry by selecting the first substitute element from the Blinders substitute class, the first element from the Wheels class, etc. We create the second instance by changing only one of the possible selections (a new combination of substitute class elements changed by one element), create the third instance by making one more change, and so forth. Again, to reiterate in mathematical form what was stated loosely in Section I.C, the length of the universe vector, denoted *M*, is the multiplication of all possible combinations of substitute components in the N classes of the Substitute Map:

$$M = \prod_{n=1}^{N} Count(Class_n) \tag{14}$$

where *Count* counts the number of elements in the class (again, this follows from the substitution classes' independence from one another). Thus, we can represent the entire substitution universe by an *M*-length vector full of 1s, each 1 representing the availability of that instance in this design universe, referred to as the "availability version" of the Universe, U_{avail}.

$$U_{avail} = \begin{bmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{bmatrix} \tag{15}$$

Business and product rules may then be applied to eliminate or reduce the value of available instances to a given party. Thus, if the first combination were available U_{avail}[0]=1 and if it were unavailable (e.g., restricted by the other party's patent, by the party's business circumstances, etc.) then U_{avail}[0]=0.[56]

56. U_{avail}[0] is the first instance since the reference is "zero-based" indexed.

However, in assessing the value of a universe, a party may choose to practice *only* a single substitute combination instance or may choose to practice a *combination* of substitute instances. Thus, we should include all *possible combinations* of substitute instances within U_{avail} rather than only the individual substitute combinations. This can be quite a large number–indeed U_{avail}'s total size now is[57]

$$\sum_{k=1}^{M} \binom{M}{k} \tag{16}$$

As a practical matter, however, we often need only consider no more than 2 or 3 combinations (the sum is then from 1 to 2 or 3, rather than up to *M*).[58]

Expanding the universe to include combinations of substitute instances is quite helpful, as our valuation function $Univ\,Val_{P,B}$ now need only consider each universe entry individually. Accordingly, we now seek a function F_Cval, e.g., for Party B, F_Cval_B which accepts a combination of substitute instances (recognizing that a "combination" may also be a single instance) as an argument and produces the value of that combination to a given party. Thus, the practice value of a universe to Party B is simply:

$$Univ\,Val_{P,B}(U) = \max_{i\,\in U} F\_Pval_B(i) \tag{17}$$

The royalty value of a universe $Univ\,Val_{R,B}(U)$ similarly determines the maximum royalty revenue generating combination of substitute instances, using a corresponding function F_Rval_B to determine the royalties available from a given instance:

57. To the mathematically uninclined, in words, this equation is simply clarifying the number of ALL possible combinations of instances. For example, let us say we have a substitute map with two categories and two possible substitutes in each category. This means there are four possible instances (2*2=4). In theory, a firm could make only each of those instances, a combination of two of those instances, a combination of three, and a combination of 4 (i.e., all four instances). The total number we are seeking is thus the sum of all these possible combinations (hence the sum in Equation 16). Each of the combinations selects a set of one (four choices), then of two (six choices), then of three (four choices), and finally of four instances (only one choice). Each of these selections is referred to as "n choose k" (four choose one, four choose two, four choose three, etc.) and is represented by the parenthetical in Equation 16 (where, in this example, *M* would be 4).

58. Toys and cereal are, e.g., exceptions, where many new and disparate offerings often enhance value collectively, possibly as part of an oligopoly dynamic. *See, e.g.*, Aviv Nevo, *Measuring Market Power in the Ready-to-Eat Cereal Industry*, 69 ECONOMETRICA 307, 307–08 (2001) (Explaining how the "Ready-to-Eat Cereal Industry" is a "classic example of a concentrated differentiated-products industry in which price competition is approximately cooperative and rivalry is channeled into advertising and new product introduction.").

$$Univ\ Val_{R,B}(U) = \max_{i \in U} F\_Rval_B(i) \tag{18}$$

This is all well and good in theory, but how, in practice, is one to "restrict universes" based upon a party's portfolio and to assess the value of a given combination of substitute instances, whether for practice or royalty value? As discussed in the introduction, RBPA is intended to mitigate the harmful effects of the Lanchesterian "categorization and ranking" approach by introducing topology. Accordingly, our goal is not so much to calculate Equation 5 with rigorous quantitative perfection (which is impossible in any event), but to provide a mechanism for *arriving at a conclusion* regarding two portfolios' relative merits and to *rigorously document* (for ourselves and for posterity) the means by which we arrived at this assessment. An example approach for making this conclusion and documenting our analysis is provided in the next section.

C. Rules and Parity Calculators

While there are many ways to implement the methodology of Section II.B, RBPA applies "business," "product," "claim," and "valuation" "rules" (See FIG. 1 and accompanying discussion) to calculate $\Delta Val_{P,A\rightarrow B}$ and and $\Delta Val_{R,A\rightarrow B}$ for a given SM design universe. FIG. 10 illustrates the application of rules for Party B graphically (again, one would apply Party B's business and product rules for the ex-ante combination determination, but additionally Party A's patents, for the ex-post combination determination).

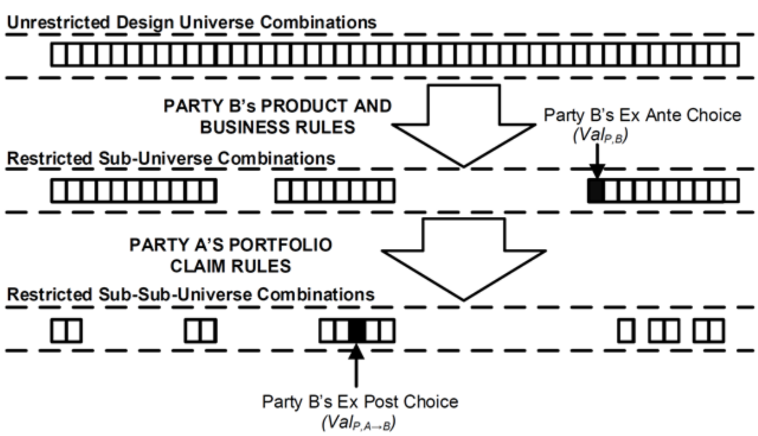

FIG. 10: Schematic Depiction of Calculator Operation

First, given an SM design universe, all possible combinations are available to the party at the "Unrestricted Design Universe Combinations." A tentative value may be ascribed to each combination using F_Pval_B and F_Rval_B. One may then apply "Party B's Product and Business Rules" to remove, or modify, the value of various combinations to produce the "Restricted Sub-Universe Combinations." Application of F_Pval_B and F_Rval_B may then be used to determine Party B's "Ex Ante" choice of combination, in accordance with the maximum determinations of Equations 17 and 18 respectively. As indicated by Equation 11 this will provide $Val_{P,B}$ and, *mutatis mutandis*, $Val_{R,B}$. The available combinations and values may then be further restricted in accordance with the other Party's (here Party A's) patent "Portfolio Claim Rules" to produce a "Restricted Sub-Sub-Universe" of combinations. One may then again apply F_Pval_B and F_Rval_B to determine Party B's "Ex Post" choice, whose value will be $Val_{P,A\rightarrow B}$ and $Val_{R,A\rightarrow B}$ respectively.

Often, however, if Party B has already made a choice about what combination to pursue in view of all Party A's patents relevant to the analysis, then Party B's Ex-Post choice, and consequently, $Val_{P,A\rightarrow B}$ and $Val_{R,A\rightarrow B}$, may *already* be known.[59] When this is the case, one may take $Val_{P,A\rightarrow B}$ and $Val_{R,A\rightarrow B}$ as a baseline value of 1 and then represent $Val_{P,A\rightarrow B}$ and $Val_{R,B}$ as a multiple of this value (e.g., but for Party A's patents, Party B may be able to capture three times its present royalty value, in which case, $Val_{R,B}$ is 3 and $Val_{R,A\rightarrow B}$ is 1).

The Author has found that first class function languages, such as JavaScript, wherein functions may be passed as arguments to other functions, are especially suitable for representing an SM, determining combinations, and implementing rules. Function passing is convenient for rule application and recordation as it allows, say, an attorney, to easily build upon rules created by an engineer or marketing expert.

An example calculator for determining $Val_{P,B}$ given a $Val_{P,A\rightarrow B}$ of 1 for the horse and buggy hypothetical is available from the Author upon request. A screenshot of the system is provided below:

59. For example, royalty and product revenue may be explicitly or implicitly disclosed in 10K filings with the Securities and Exchange Commission ("SEC").

FIG. 11: Screenshot of the Example RBPA calculator

This simple example runs in a browser. Product, Business, Claim, and Valuation rules appear in Region A. Selecting the checkbox in Region A may disable the rule's application during an analysis and selecting the rule's name may present its details in Region B. A substitute map is provided in Region C. Patents from each of Parties A and B are shown in regions E and F respectively. Selecting a patent presents its claims in Region D to facilitate assigning a qualifier to a substitution map component. Individual instances available following rule application are shown in Region G and combinations of these instances in Region H.

In such a system, a business rule that a Party cannot source a substitute can be represented by a general removal rule, as shown in FIG. 12.

```
var rule_remove_item = function(txt){ return function(u_inst,u_combo){
        for(var i = 0; i < u_inst.length; i++){
                for(var j = 0; j < u_inst[i].instance.length; j++){
                        var item = u_inst[i].instance[j];
                        if(item.sub_name == txt){
                                u_inst.splice(i, 1);
                                i--;
                                break;
                        }
                }
        }
}
```

FIG. 12: Example Removal Rule in JavaScript

This function "rule_remove_item" receives a single argument "txt" indicating the name of the substitute component to be removed from the SM combinations. The function then returns a second function in the standard rule form, that is, a function which receives a universe of instances and a universe of combinations as inputs for operations thereupon. Here, the rule function simply removes all instances having the specified substitute component. For example, let us say Party A lacks the capacity to implement carriages with horses. This may be implemented by adding a rule generated by calling rule_remove_item ("Horse").

Certainly, not all RBPA calculators need take this form. Rather, this example should help the reader appreciate the feasibility of creating a calculator suitable to the reader's own situation (this browser-based example taking only a few hours to construct). By separating rules into an Extended Markup Language (XML) file, or the like, an organization can readily document its assessment for future reviewers.

D. Degrees of Precision

If one feels overwhelmed by the potential complexities in applying RBPA via a software calculator, this section reiterates again that our goal is simply to find a more rigorous approach than "ranking and categorization" via the Lanchesterian perspective. We can achieve this goal in varying degrees as represented in FIG. 13 which, for reasons of formatting, is provided as a list rather than flow diagram:

1. Does data exist for <u>complete</u> Ex-Ante and Ex-Post preference characterization?
   a. If so, perform a <u>complete</u> analysis calculating $Val_{P,B}$, $Val_{P,A\to B}$, $Val_{R,B}$, $Val_{R,A\to B}$, and $Val_{P,A}$, $Val_{P,B\to A}$, $Val_{R,A}$, $Val_{R,B\to A}$, explicitly with "raw" rules
2. If not #1, does data exist for <u>only</u> complete Ex-Post preference characterization?
   a. If so, perform a <u>scaled</u> analysis setting $Val_{P,A\to B}$, $Val_{R,A\to B}$, $Val_{P,B\to A}$, $Val_{R,B\to A}$ to 1 and calculating $Val_{P,B}$, $Val_{R,B}$, $Val_{P,A}$,$Val_{R,A}$ with "scaling" rules
3. If not #2, is the estimation of preferences possible or is the topology describable in words?
   a. If so, enumerate and record topology considerations as well as strategic responses thereto
4. If not #3, perform a traditional "categorization and ranking" parity comparison.

FIG. 13: Analysis Precision Given Data Availability

As indicated, initially at Step 1, the practitioner may ask herself if adequate data exists to specify the actual value of ex-ante and ex-post preferences of both parties (e.g., in a well-established technical field where existing and varied market data is readily accessible). If so, at Step 1.a, the practitioner can perform a "complete" parity analysis involving "raw" rules. For example, the valuation rules may specify the market value, in dollars, of a given design universe to a party.

If this data is not available, then at Step 2, the practitioner may consider whether they can at least determine each party's ex-post preferences. For example, quarterly filings in the Securities and Exchange Commission's Electronic Data Gathering, Analysis, and Retrieval ("EDGAR") database will regularly include existing licensing and product revenues. If the patents in question are presently in force, these values may be used to infer, e.g., $Val_{P,A \to B}$ and $Val_{R,A \to B}$. In this case, valuation and other rules may then assess universe value as a scaled percentage of this orienting value. Particularly, taking this value as 1, $Val_{P,B}$ and $Val_{R,B}$, e.g., may be represented as some multiplicative factor, e.g., 1.2 and 1.4.

If even this data is unavailable, then at Step 3, if the practitioner can still at least characterize the topological situation, then she can record her understanding and strategic intentions (this can be as simple as a documented list) for herself and posterity. This at least provides some explanation to future decision makers, for why particular prosecution and acquisition decisions were made.

Only when the topology is completely beyond the ken of the practitioner should they consider falling back on the Lanchesterian approach at Step 4.

In addition to the varying degrees of precision, one can further simplify their analysis by addressing portfolios at higher levels of the portfolio hierarchy. That is, a party's portfolios may be decomposed into a hierarchy as shown in FIG.14.

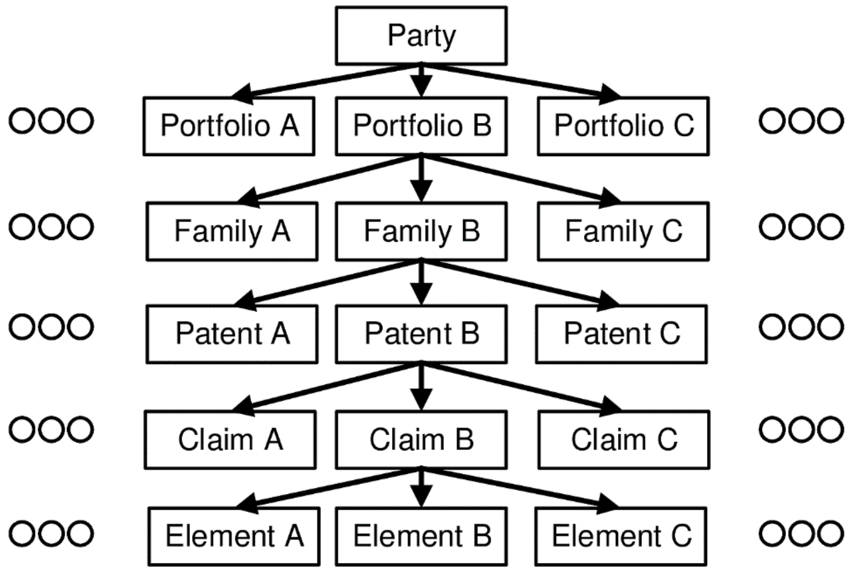

FIG. 14: Hierarchic Levels of Possible Analysis

Thus, one can perform parity analysis applying entire portfolios as qualifiers to elements in the SM. More granularly, one can apply patent families rather than portfolios, patents rather than families, claims rather than patents, etc. While the examples above generate substitutes based upon element separation at the claim level, one can also combine these elements to simplify analysis.

Finally, from a computational perspective, one can simplify the analysis by only considering patented substitutes in the SM. That is, if one considers the Equations of Section II carefully, one will recognize that instances without patent coverage will not effect any change between ex-ante and ex-post value assessments (though combinations *may* have different values to a party). Thus, one can often reduce the number of instances generated to only those created by varying SM substitution classes containing a patented element.

III. Considerations in Parity Calculation

This section briefly discusses various legal doctrines which may impact when and how RBPA is applied. Much more can be said about RBPA's application to real-world situations and so these sections are meant merely to provide some context for the reader to apply the preceding discussion to their actual situation.

A. Treble Damages

Under 35 U.S.C. § 284, a court may award treble damages for infringement.[60] While courts typically only multiply damages for flagrantly willful infringement, unfortunately, the threat of treble damages has caused many entities to avoid reviewing competitors' portfolios, finding it "safer" to "hide their heads in the sand." Note that this reasoning applies as much to the Lanchesterian "rank and categorize" approach as to topological analysis (though RBPA calculators afford certain countermeasures, discussed below). The *Seagate*[61] decision mitigated this concern somewhat, providing a framework for assessing willfulness. However, in the subsequent 2016 Supreme Court decision *Halo v. Pulse*,[62] while noting that treble damages "are not to be meted out in a typical infringement case" the Supreme Court eschewed "any rigid formula for awarding enhanced damages under § 284" and rejected . . ." the Federal Circuit's tripartite framework for appellate review."[63] Since *Halo*, there has been no "bright-line" rule for what knowledge suffices for willful infringement.[64] Thus, even when kept

60. 35 U.S.C. § 284 (2018) ("[T]he court may increase the damages up to three times the amount found or assessed.").

61. In *In re* Seagate Tech., LLC, 497 F.3d 1360, 1371 (Fed. Cir. 2007), CAFC adopted a two-part test, wherein a patent owner must: 1) show by clear and convincing evidence that the infringer acted despite an objectively high likelihood that its actions constituted infringement of a valid patent, and; 2) demonstrate, again by clear and convincing evidence, that the risk of infringement was either known or so obvious that it should have been known to the accused infringer.

62. Halo Elecs., Inc. v. Pulse Elecs., Inc., 136 S. Ct. 1923, 1932–34 (2016) ("Awards of enhanced damages under the Patent Act over the past 180 years establish that they are not to be meted out in a typical infringement case, but are instead designed as a 'punitive' or 'vindictive' sanction for egregious infringement behavior . . . [t]he *Seagate* test reflects, in many respects, a sound recognition that enhanced damages are generally appropriate under § 284 only in egregious cases . . . . Section 284 allows district courts to punish the full range of culpable behavior. Yet none of this is to say that enhanced damages must follow a finding of egregious misconduct. As with any exercise of discretion, courts should continue to take into account the particular circumstances of each case in deciding whether to award damages and in what amount . . . [c]onsistent with nearly two centuries of enhanced damages under patent law, however, such punishment should generally be reserved for egregious cases typified by willful misconduct.") (citations omitted).

63. *Id.* at 1927.

64. SiOnyx, LLC v. Hamamatsu Photonics K.K., 330 F. Supp. 3d 574, 609 (D. Mass. 2018) ("Multiple district courts, post-Halo, have held that neither general knowledge of a patent portfolio nor actual knowledge of a patent application or of related patents, without more, is sufficient even to plausibly allege knowledge of a particular asserted patent.") (citation omitted); Finjan, Inc. v. Juniper Networks, Inc., No. C 17-05659 WHA, 2018 U.S. Dist. LEXIS 25323, at *3 (N.D. Cal. Feb. 14, 2018) (knowledge of other patent in family not enough); Bayer Healthcare LLC v. Baxalta Inc., No. 16-1122-RGA, 2017 U.S. Dist. LEXIS 126904, at *2–3 (D. Del. Aug. 10, 2017) (knowledge of parent application, not enough);

confidential, one may be reluctant to perform a thorough parity analysis of a portfolio involving patents one may be inadvertently practicing.

That said, there are several reasons why treble damages' specter should not always deter a practitioner from deep and involved topological parity analysis. First, as discussed in greater detail below with regard to parity networks, practitioners regularly assess *other* entities' postures for potential deals. Often, this assessment can be performed with some confidence that the patents involved have no bearing on the analysts' activities.

Second, as discussed below, one benefit of RBPA calculators is that they allow one to posit "hypothetical" patents and to see their effects *if* they exist. While this is a good practice for anticipating future portfolio developments, it can also be used to assess portfolio effects without reviewing specific patents. Multiple district courts post-*Halo* have held that "neither general knowledge of a patent portfolio nor actual knowledge of a patent application or of related patents, without more," is sufficient to plausibly allege knowledge of a particular asserted patent.[65] Speculation about a "hypothetical" patent would seem even further removed from this determination.

Third, in markets with competitive, nascent R&D, practitioners regularly perform a "clearance" function, identifying competitor patents to attack via an inter partes review ("IPR") before entering a market (and pursuing an alternative when the IPR fails). In these situations where the analyst is not yet practicing the patent, the opportunity to examine variations in asset strategies and possible Doctrine of Equivalents opportunities can facilitate more productive R&D, prosecution, and licensing discussions. Such benefits likely greatly outweigh the risk of damages.

Fourth, parity analysis may be performed by neutral third parties who may report only the relevant rules or results from their analysis without identifying specific patents. This approach may be especially common among standards-setting and trade organizations where a central entity must

Windy City Innovations, LLC v. Microsoft Corp., 193 F. Supp. 3d 1109, 1117 (N.D. Cal. 2016) (allegations that defendant knew of an unasserted patent and the application that later issued as the asserted patent not enough to plausibly allege knowledge of asserted patent); Finjan, Inc. v. Cisco Sys. Inc., No. 17-cv-00072-BLF, 2017 U.S. Dist. LEXIS 87657, at *13 (N.D. Cal. June 7, 2017) ("Knowledge of a patent portfolio generally is not the same thing as knowledge of a specific patent.") (citation omitted); *see also* Verint Sys. Inc. v. Red Box Recorders Ltd., 14-cv-5403 (KBF) 2016 U.S. Dist. LEXIS 169377, at *2 (S.D.N.Y. Dec. 7, 2016) (summary judgment)).

65. *Compare supra* note 64 and accompanying text, *with* WCM Indus., Inc. v. IPS Corp., 721 Fed. Appx. 959, 970–71 (Fed. Cir. 2018) (Upholding a jury verdict of willfulness where, in part, the defendant "was aware of a 2010 patent lawsuit between" the plaintiff and a company acquired by the defendant "at the time of the acquisition.").

evaluate the patent landscape for the benefit of its members. Participants in a patent platform or pool are also regularly compelled to identify assets of theirs which are “standards essential.”[66] A parity analysis by the central organization may provide a more rigorous basis for assessing such “essentiality” as opposed to simply soliciting the opinions of other members or a committee.

Fifth, as evidenced by Section II, much of parity analysis *doesn’t even involve patents*. One can draft product rules, market rules, business rules, valuation rules, and introduce one’s own patents *without even yet considering the other party’s portfolio*. This exercise alone can help one understand one’s position and strategy more thoroughly and to better guide one’s choices during prosecution.

Finally, it is often “too late” to avoid exposure to a competitor’s patents. With aggressive marking and advertising, it may be implausible to assert that one has never encountered a peer’s portfolio. Indeed, even if one applies the most draconian internal censorship possible, if an entity prosecutes its own patent portfolio in the same technical space as a competitor, a patent Examiner will almost inevitably cite at last some of the competitor’s patents as prior art. In these situations, the cost savings afforded by RBPA’s more nuanced topological approach over the more brute force “rank and categorize” can be used to redirect funds to acquiring noninfringement opinions.

Ultimately, firms will need to balance the potential costs of treble damages with the benefits of meaningful topological review. While, undoubtedly, there will be some situations where that balance argues against review, as discussed above, there are *many* instances where the balance favors the analysis.

B. Parity Networks

Parity is not (necessarily or even usually) transitive. That is, if Parity(A,B)=.2 and Parity(B,C)=.2 then Parity (A,C) is *not* necessarily 0.2. On the contrary, product and business rules can change radically between parties. Transitivity’s absence is important when considering coalition

66. Regarding clearance procedures, *see, e.g.*, James Skelley, *Coordinating the Offshore Energy Transition: A Legal Economic Framework*, 23 B.U. J. SCI. & TECH. L. 241, 280–84 (2017). The “essentiality” of a patent is often not fixed. Substitutes may appear on the market, business and customers may change, etc., and the topologies of FIG. 1 are in constant flux. By recording the RBPA rules used to identify essential patents initially, the SSO can reevaluate over time whether the original reasoning underlying that assessment remains valid over time. The SSO, as the non-implementing entity, can also review patents more thoroughly without being as concerned about the risk of treble damages.

formations between portfolio and *even non-portfolio* holding entities (either in an explicit joint defense/offense agreement or when taking an assignment or license). FIG. 15 illustrates an example of topological relation between three parties A, B, and C and their respective portfolios.

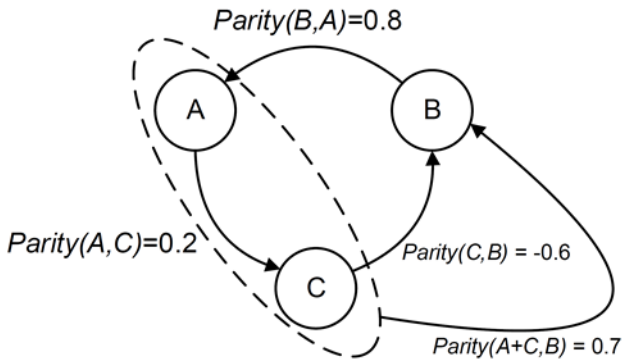

FIG. 15: Hypothetical Parity Network

As indicated Parties A and C are each in a weaker relative position as to Party B, having negative parity values whenever parity is taken from them to Party B alone. However, it is entirely possible that their *combined* portfolios effect a strong displacement upon Party B. This may happen, e.g., when each of Parties A and C possess only one of the only two viable substitutes available to Party B. By foreclosing all of the substitutes, their collective position relative to Party B may be greatly improved. By permitting rule sharing between analysts, systems like RBPA are more likely to facilitate creative identification of such possibilities between Parties A and B than the typical Lanchesterian "rank and categorize" approach would elucidate.

C. Markov Models and Monte Carlo Methods

While beyond the scope of this paper, coalitions within parity networks and even factual variations within a single parity analysis may be readily considered using Monte Carlo and Markov Model techniques in conjunction with an RBPA calculator.[67] While many economic models are readily available to determine the demand for a given product combination using

67. *See, e.g.*, Jacob B. Feldman, Huseyin Topaloglu, *Revenue Management Under the Markov Chain Choice Model* (March 29, 2017), https://people.orie.cornell.edu/huseyin/publications/mc_revenue.pdf.

Markov Models, one can also use these methods to validate valuation and business rules, as well as "stress-test" prosecution strategies to determine what factors most influence a portfolio's strength.

Monte Carlo methods may also sometimes be used to obviate the need for expensive legal counsel as in the "rank and categorize" approach. Rather than having outside counsel meticulously analyze each asset and assess its validity (counsel's opinion ultimately being, just that, an opinion), in-house counsel can make an educated guess. This guess may form the variance of a distribution used to anticipate possible parity outcomes. One can thereby ascertain important information about peer portfolios portfolio more quickly and with less cost using an internal RBPA calculator.

CONCLUSION

This Paper has argued for increased topological consideration in portfolio management over the relatively predominant "Lanchesterian categorization and ranking" approach, providing RBPD as one example method for topological portfolio assessment. The Author appreciates that many practitioners may consider aspects of rule-determination in RBPD beyond their responsibility and expertise. However, the Author has also regularly encountered practitioners who complain that their organizations see their portfolio development responsibilities as little more than a "necessary cost."[68] While successful marketing team members, prolific engineers, and corporate directors regularly receive enhanced compensation, these practitioners find themselves eschewed whenever possible by the very organizations they were hired to protect. By adopting a proactive, topologically-aware approach to portfolio development, instead of the Lanchesterian approach, not only can these practitioners achieve better results for their organization, but they can also find a vehicle to creatively incorporate business objectives into their patent prosecution, licensing, and acquisition efforts. In view of the increasingly competitive research and development environment recognized by Bessen and Meurer, as well as the increased scrutiny of activist shareholders, such creativity and value are especially relevant to modern IP procurement.

68. The Author has attended a number of events for patent professionals where practitioners regularly lament their situations but seem to reapply existing methods. To paraphrase the common adage: "Insanity is doing the same thing over and over again and expecting different results."