WHAT LOGIC CAN AND CANNOT TELL US ABOUT LAW

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While a symposium on logic and law should probably focus on what logic can do for law, there is also a "cannot" aspect of the relationship between logic and law that deserves some mention. In fact, there would appear to be at least three paths through the study of logic that might provide some insight into, or help to, law, but one of those paths is a dead end. While the second leads to some enlightenment, it should be followed with some caution. The third path, if it could be followed, would be of great benefit, but it is not adequately blazed. The first, dead-end path is the use of logic to divine something of the nature of law itself, that is, to attempt to resolve jurisprudential questions. The second is the use of logic in analyzing the practice of law, that is, as a measure of the validity of legal argumentation. While that use may provide insight and lead to rigor in legal argument, there may be a tendency toward blind obedience to principles of logic that may not always be valid or fruitful in the legal arena. The third is the role of logic in making law amenable to the tools of artificial intelligence. There, however, the logic is not sufficiently developed to serve adequately its intended purpose. That is not an indictment of logic or of logic and law, but instead a call for increased effort in the area.

I. LOGIC AND THE NATURE OF LAW

Logic has been used as a tool, or a model, in discussing the nature of law where the issue has been the status of hard cases. Does the existing law *always* provide an answer to a legal question, so that the judge is never faced with situations in which there is no law and in which the judge must exercise discretion? Approaching the same issue from the other extreme might it be that law is radically indetermi-

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nate and *never* dictates an answer, so that the judge exercises discretion in all cases? This is a complex issue. It is clear that situations arise in which the proper application of law is in dispute, with past precedent or statutes not squarely on point, but there are jurisprudential theories that suggest how the interpretation of law might lead to solutions in those situations.[1] Certainly logic can play a role in assessing the strength of the arguments in that jurisprudential debate. The issues are somewhat philosophical in nature, and it is to philosophy and mathematics that logic is most strongly tied. The misuse of logic is to hold it up as a model for law in an attempt to resolve that debate. The mistake is to be found primarily in the belief that logic is a single, undisputed system that is of universal application, and that mistake seems to have been made by both sides in the debate over hard cases.

One of the earlier such seeming uses of logic is by Ronald Dworkin.[2] The "seeming" is important, because while part of his argument clearly rests on logic, a position with regard to logic colors much of the rest of his argument. He begins by characterizing the no-right-answers position as a rejection of what he calls the bivalence thesis, or what is usually called the law of the excluded middle, that is, that the compound proposition "p or ~p" must be true. Put another way, for any proposition, either the proposition or its negation must be true. Dworkin then goes on to examine and dismiss various arguments against the rejection of bivalence.

The argument rejecting perhaps the most important of the no-right-answers arguments, that of the legal positivists, contains a logical flaw. Dworkin puts the positivist position into symbols as a claim that, if "p" is a proposition of law and "L(p)" represents the fact that a person or group has acted in such a way that makes "p" true, then "p" cannot be true, unless "L(p)" is true.[3] The positivist position, which appears reasonable, is that "p" becomes a proposition of law, only when a person or body occupying a particular position has acted in such a way as to make it law. He proceeds to assert then that "~p" cannot be true unless "L(~p)" is true.[4] If the person or body in the required position has not acted toward "p" or toward "~p," that is if both "L(p)" and "L(~p)" are false, then the positivist concludes that "p" and "~p" are both false, and bivalence fails.

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1 *See, e.g.*, RONALD DWORKIN, LAW'S EMPIRE (1986).

2 *See* Ronald Dworkin, *No Right Answer?*, 53 N.Y.U. L. REV. 1 (1978).

3 *See id.* at 16.

4 *See id.*

Dworkin's rejection of this argument is based on an assertion that the positivist is assuming a distinction between "L(~p)" and "~L(p)" that does not in fact exist. He argues that, if "L(p)" is equivalent to "p," then "~p" is equivalent to "~L(p)," and since "~p" is equivalent to "L(~p)," "~L(p)" and "L(~p)" must be equivalent.[5] Since it would appear to be sound to argue that either "L(p)" or "~L(p)" must be true, that is, that bivalence does hold here, then either "p" or "~p" must be true. The problem, however, is in his assumptions with regard to the relationship between "L(p)" and "p." The positivist can agree with, and indeed builds his or her theory on, the assertion that "p" is a proposition of law if and only if L(p), but the real equivalence here is between "'p' is a proposition of law" and "L(p)," not between "p" and "L(p)." There is then also a similar equivalence between "'~p' is a proposition of law" and "L(~p)," but not between "~p" and "L(~p)," so the argument breaks down.

What is perhaps more important than this logical error in an article containing other strong nonformal arguments is a general tenor that there is something suspect in denying the thesis of bivalence. This is a belief that logic can tell us something of the nature of law, but in fact the resort to the nature of logic simply shifts the argument from a debate over the nature of law to an equivalent debate over the nature of logic. There is, once again, not a single, universally applicable system of logic. The debate over whether one of "'p' is a proposition of law" or "'~p' is a proposition of law" must be true is similar to a problem discussed by Aristotle.[6] For the positivist, where the sovereign has not acted, both alternatives represent future contingents, similar to Aristotle's example, ["t]here will be a sea battle tomorrow." Tomorrow it will be either true or false that there is a sea battle, and once a judge has spoken "p" or "~p" will be law, but what are the truth values of those propositions today? Is the truth value today simply the same as it will be tomorrow, though today unknown, or are the statements neither true nor false?

While the law of the excluded middle holds that one of the two is true today, that "law" represents only one response to the issue of indeterminates. The two potential responses were taken up by different post-Aristotelian schools of philosophy. The Stoics, in keeping with their determinist metaphysics, adopted the principle of bivalence. Since the occurrence or non-occurrence of tomorrow's sea battle is already determined by past events, the truth value of the sea battle

5 *Id.* at 18.

6 A.N. Prior, *Many Valued Logics, in* 5 ENCYCLOPEDIA OF PHILOSOPHY 1, 1 (Paul Edwards ed., 1967).

proposition is already fixed today. The Epicureans, in contrast, allowed for indeterminacy in their metaphysics, where chance occurrences or human choice played a role. In keeping with that position, they rejected the principle of bivalence and held that the sea battle proposition is neither true nor false but of indeterminate or neuter truth value.

The truth value of future contingents continued as a focus of discussion for Medieval logicians. Duns Scotus and Ockham considered neuter propositions as being different from those that are either true or false, and their work might be viewed as early attempts at developing three valued logics. An indeterminate truth value, however, caused problems for other scholars of the Christian era. Thomas Aquinas and others rejected the possibility of an indeterminate truth value, because it implied that there could be no Divine foreknowledge where future contingents were involved. If the proposition was indeterminate, then not even God could know whether there would be a sea battle tomorrow. Such theological concerns were debated from Medieval times and are of interest even in the modern era.[7] The result of the Christian influence was the continued development of two valued logic, while three valued logic was dormant until the late nineteenth century.[8] Thus, while it might seem that the no-right-answers position could be refuted by showing it to be inconsistent with the most common system of logic, in fact, the effort simply turns the debate into one about logic that is of even older vintage and perhaps even less subject to resolution.

Logic or metalogic had also been a tool of those who would argue that there are cases with no right answer. Professors Farago,[9] Rogers and Molzon,[10] Brown and Greenberg,[11] and D'Amato,[12] among others, have all attempted to find some insight into the nature of law through an examination of the implications of Gödel's Theorem.[13]

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7 *See, e.g.*, A.N. Prior, *The Formalities of Omniscience*, 37 PHILOSOPHY 114 (1962).

8 For a brief history of the development of three valued logic, see Prior, *supra* note 6, and NICHOLAS RESCHER, MANY VALUED LOGIC 1–16 (1969).

9 *See* John M. Farago, *Intractable Cases: The Role of Uncertainty in the Concept of Law*, 55 N.Y.U. L. REV. 195 (1980).

10 *See* John M. Rogers & Roger E. Molzon, *Some Lessons About the Law from Self-Referential Problems in Mathematics*, 90 MICH. L. REV. 992 (1992).

11 *See* Mark R. Brown & Andrew C. Greenberg, *On Formally Undecidable Propositions of Law: Legal Indeterminacy and the Implications of Metamathematics*, 43 HASTINGS L.J. 1439 (1992).

12 *See* Anthony D'Amato, *Can Legislatures Constrain Judicial Interpretation of Statutes?*, 75 VA. L. REV. 561 (1989).

13 For a discussion of Godel's Theorem and an explanation of the proof, see ERNEST NAGEL & JAMES R. NEWMAN, GODEL'S PROOF (1958).

Gödel's Theorem demonstrates that any formalization of arithmetic is incomplete; that is, whatever axioms are used as the basis for proving the theorems one would expect to hold for arithmetic, there will always be arithmetic propositions for which neither the proposition nor its negations can be proved using those axioms. Since Gödel's Theorem proves that there will always be gaps, the addition of further axioms for arithmetic will not fill the gaps. There will always remain an infinity of unprovable propositions.

Professor D'Amato's position is that Gödel's Theorem carries over to law. If so, there will always be an infinity of legal propositions that can be neither proved nor disproved.[14] Similarly, Brown and Greenberg conclude that "Gödel's Theorem reveals that the law cannot be a determinate formal system."[15] Professors Rogers and Molzon, seemingly reluctant to apply Gödel's Theorem directly to law, nonetheless state "Gödel's Theorem strongly suggests that it is impossible to create a legal system that is 'complete' in the sense that there is a derivable rule for every fact situation."[16]

Professor D'Amato also draws guidance from the Löwenheim-Skolem Theorem, which states that for any axiom set for an area of mathematics there will be an infinite variety of alternate interpretations or models for those axioms.[17] Put another way, for any attempt to develop a set of axioms from which the properties of a particular mathematical model may be derived, there will be alternative mathematical systems that also satisfy the same axioms. Based on the Löwenheim-Skolem Theorem, D'Amato concludes that "even a highly formalized set of rules, such as the Restatements of Contracts and Torts, can consistently be said to 'apply' to mutually inconsistent descriptions of fact situations."[18]

Professor Ken Kress attacks these uses of metamathematics to draw conclusions about the nature of law.[19] As he points out, the

14 *See* D'Amato, *supra* note 12, at 597.

15 Brown & Greenberg, *supra* note 11, at 1487. Brown and Greenberg's conclusion that law cannot be a determinate "formal system" might be read to allow the possibility that law is a determinate informal system, but it seems unlikely that they would take that position. Specifically addressing such a possibility, D'Amato argues that if law is a nonformal system, it's very informality must make it indeterminate. *See* Anthony D'Amato, *Pragmatic Indeterminacy*, 85 Nw. U. L. Rev. 148, 176 n.92 (1990).

16 Rogers & Molzon, *supra* note 10, at 992.

17 *See* Anthony D'Amato, *Can Any Legal Theory Constrain Any Judicial Decision?*, 43 U. Miami L. Rev. 513, 521 n.28 (1989).

18 D'Amato, *supra* note 15, at 175–76.

19 *See* Ken Kress, *A Preface to Epistemological Indeterminacy*, 85 Nw. U. L. Rev. 134 (1990).

Löwenheim-Skolem Theorem only applies to rigorously defined formal systems, stating:

> English][and legal language are insufficiently precise for the assertions and inferences of a formal proof such as the Löwenheim-Skolem theorem to be true and valid about them. As mathematicians put it, the Löwenheim-Skolem proof will not "go through" in legal English. There is therefore no reason to suppose that the conclusion of the proof, the Löwenheim-Skolem theorem, is true in legal English . . . .[20]

In response to Kress, D'Amato continued to assert that the Löwenheim-Skolem Theorem is relevant to law, but he argues in the alternative that, if legal English is not sufficiently formal for Löwenheim-Skolem to apply, that also demonstrates the indeterminacy of law; that is, if law is not as formal as formal systems that are themselves indeterminate, law must also be indeterminate.[21]

The same variety of attack as that directed at the use of the Löwenheim-Skolem Theorem may be offered with regard to the application of Gödel's Theorem to law. The proof of Gödel's Theorem required that Gödel express the metalanguage for arithmetic, the language used to talk about arithmetic, within arithmetic itself.[22] The theorem rests on Gödel numbering in which propositions and theorems of arithmetic are coded as numbers, the subject of arithmetic. If Gödel's Theorem is to apply to law, it would appear that the same task would have to be accomplished for law. It is not sufficient to note that law may be self-referential or that law, like mathematics, may have rules and metarules.[23] An analog of Gödel's Theorem would require a demonstration that the metalanguage of law, legal English, can in some sense be embedded in the law. It is far from obvious that that can be accomplished; it is not even clear what it means.[24]

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20 *Id.* at 144.

21 *See* D'Amato, *supra* note 15, at 176 n.92.

22 *See* NAGEL & NEWMAN, *supra* note 13.

23 *See* Rogers & Molzon, *supra* note 10, at 1002–21.

24 Professor Farago suggests that the procedural rules of law can serve as the metalanguage and substantive law may serve as the object language and that any formalization of law would have to encompass both forms of law. Farago, *supra* note 9, at 227. However, more is required than simply showing that both forms of law must be part of a legal system. The metalanguage must be embedded in the object language. Procedural law must be made a part of substantive law, and the debate over primary and secondary rules of law and the difficulty of fitting the secondary into the primary by using nullity as the analog of the sort of sanction contained in substantive laws demonstrate the problems inherent in such an attempt. *See, e.g.*, H.L.A. HART, THE CONCEPT OF LAW 28–35 (1961).

Rogers and Molzon do draw one important non-analytic conclusion from their examination of Gödel's Theorem. Even if Gödel's Theorem does hold for law and prove law to be incomplete, "legal theorists must become comfortable with the incompleteness of legal systems, no matter how carefully constructed, in the same way that mathematicians and philosophers have become comfortable with the incompleteness of axiomatic systems of number theory."[25] That is an important observation. The fact that incompleteness has not hobbled mathematicians, working with the seeming paradigm of certainty should relieve any anxieties over what Gödel's Theorem might say about the incompleteness of law. Furthermore, as I have argued elsewhere,[26] incompleteness is a far lesser weakness than the radical indeterminacy that some argue is true of law. Incompleteness means only that there are propositions for which neither the proposition nor its negation is provable. Even with the infinity of such propositions Gödel proved are present in any formalization of arithmetic, there are still propositions of arithmetic that are provable. Thus, even if Gödel's Theorem did carry over to law, it would only show that there are hard cases, even an infinity of them, but not that all cases are undecidable.

In this last respect, that is with regard to the fact that logic or mathematics has been capable of handling difficult situations thereby providing hope for proceeding in the face of analogous difficulties in law, one additional word should be said. Scholars in the Critical Legal Studies movement (the Crits) have argued that law is hopelessly conflicted and have pointed to what they see as contradictions in particular areas of law as evidence.[27] If classical logic were to be the guide as to the nature of legal systems containing such contradictions, the picture would be grim. Under the principles of propositional logic anything and everything may be implied from a logical contradiction. Thus, once one contradiction is found, any other proposition and its negation are both provable, and the entire system is comprised of contradictions. Under such a logic, the identification of one of the contradictions the Crits assert would logically lead to the conclusion that the entire system of law is contradictory. Here, too, it is important to

25 Rogers & Molzon, *supra* note 10, at 992.

26 *See* Kevin W. Saunders, *Realism, Ratiocination, and Rules*, 46 OKLA. L. REV. 219, 229 (1993).

27 For an overview of the Critical Legal Studies movement, see MARK KELMAN, A GUIDE TO CRITICAL LEGAL STUDIES (1987). The arguments of the Crits do not proceed only from examples but also draw power from the presence of psychological conflict in each individual leading to opposing desires for the role of law. This conflict, tugging law in opposing directions, gives rise to conflicting legal outcomes.

note that logic is not a single, universally applicable system. Indeed, there is ongoing work to develop logics capable of handling contradictions without leading to the entire system being contradictory. Those logics, known as paraconsistency logics,[28] have been seen to have some application in law.[29] Under such a logic, the individual conflicts identified by the Crits would not logically lead to universal legal conflict.[30]

The recognition that paraconsistency logic could be useful in law rests on the position that logic is a tool rather than simply a standard. If paraconsistency logic turns out to work well for law, it should be used. The same is true for other logics. Law regularly employs vague terms, and this raises difficulty under standard two valued propositional logic and its predicate logic extension. The solution may be the use of a different logic. Indeed, there is legal scholarship employing fuzzy logic, in which membership in a class is not a yes or no proposition but one that takes a value on the interval from zero to one.[31]

This suggestion that law serve as a tool rather than as a standard may appear caviler, and indeed the immediate reaction, when law or legal argument faces logical difficulty, should not be the rejection of logic. Nonetheless, if after serious consideration of the difference between a legal position or view as to the nature of law and logic, one is not willing to give up the legal position, it may well be the logic that is not up to the task. The concept of entailment of one proposition from another in law may differ from that expressed by the connective in propositional logic. The concept of a search being reasonable may be fuzzy rather than two valued. The complex nature of the legal proposition may make it practically unamenable to inclusion within the formulae of the logical system under consideration.

II. LOGIC AND THE PRACTICE OF LAW

The use of logic to analyze and evaluate the sort of argument used in the practice of law would appear more promising, and indeed,

28 The ground breaking work in this area is that of Graham Priest. *See* GRAHAM PRIEST, IN CONTRADICTION: A STUDY IN THE TRANSCONSISTENT (1987); PARACONSISTENT LOGIC: ESSAYS ON THE INCONSISTENT (Graham Priest et al. eds., 1989).

29 A recent conference in Ghent, Belgium, in the summer of 1997, included papers such as Francisco Jose Diaz Ausin & Lorenzo Pena, *Paraconsistent Deontic Logic with Enforceable Rights* and Jair Minoro Abe & Leonardo Pujatti, *Paraconsistent Legal Knowledge Engineering* (unpublished manuscripts on file with the author).

30 The psychological conflicts discussed in *supra* note 27, to the extent that they apply universally, would still provide an argument for universal legal contradiction.

31 *See* Deborah Jones Merritt, *The Fuzzy Logic of Federalism*, 46 CASE W. RES. L. REV. 685 (1996).

it does not face the sort of problems as occurred in the use of logic to divine the nature of law. Even here, however, some caution should be exercised in treating logic as normative for the purpose of accepting or rejecting arguments. In a book, perhaps unique among those titled *Logic* for its lack of formality, John Dewey argues against taking logic as an *a priori* standard against which to measure anything. He argues that logic is a field of inquiry having at least somewhat of an empirical nature.[32] The rules and procedures for the conduct of inquiry, that is the rules and procedures of logic, should be derived from successful inquiry. Arguments that have proven successful should be the guides in developing additional arguments.

Standard propositional and predicate logic are, in effect, the study of successful or convincing argument. While they are axiomatic systems, they are systems based on axioms that capture principles that have proven successful in convincing an audience or reader. Logic does capture the forms of successful argument, but the argument forms it captures are those of philosophy, mathematics, and perhaps some of the sciences. When a legal argument fails to follow one of the forms, it is not necessarily flawed but may indicate an area in which legal argumentation differs from argument in other areas. But, while not necessarily flawed, the contravention of some rule of logic should call for an explanation as to why that rule should be disregarded for legal argument.

The best examples of acceptable legal arguments that violate what are elsewhere accepted as principles of logic are to be found in informal logic and in particular the informal fallacies. Arguments based on an appeal to authority, the *argumentum ad vericundiam*, are said to be flawed. In most situations, such an argument is in fact flawed. If two philosophers argue a point in metaphysics, the argument is not won simply by asserting that Plato held a particular position. Plato holding the view does not make it correct. It should be the strength of the argument, not the person who has asserted it, that provides its weight.[33] The same is not true of law, where there are persons whose opinions or statements, because of the position held, are entitled to weight, even to the point of being controlling. While it may not win the argument to assert the position of Plato, if the

32 *See* JOHN DEWEY, LOGIC: THE THEORY OF INQUIRY 1-22 (1938).

33 That may not be true when the argument is over some empirical issue, rather than a philosophical issue. If the debate is between two amateur cosmologists, the fact that Professor Hawking has made a statement that backs one side of the debate would appear to be the sort of appeal to authority that should not be classified as an informal logical fallacy.

Supreme Court has directly spoken on a legal issue, that fact at least goes a long way toward winning the legal debate.

A similar point regarding informal fallacies not applying to law may be made with regard to the *argumentum ad hominem*, an argument directed against the person asserting a position rather than against the argument the person offered to support the position. Again, in a philosophical debate, an argument is not weakened by the characteristics of the person offering the argument. A response of, "What would you expect from an admitted Marxist?" does not address the validity of the argument that the Marxist offered. The response should be met with the accusation that the speaker is resorting to an *ad hominem*, and the response should be dismissed. Since this has been an accepted principle, or a successful form or inquiry or argument, that would seem to provide some basis for accepting it as an informal fallacy in legal argument. However, the application to law should not be too broad. Legal argument is not only about abstract, theoretical issues, where an *ad hominem* is flawed. It is also about factual matters, and there an argument directed to the person might be appropriate. If a purported witness to a crime has a personal interest in the outcome of the trial resulting from the accusation, that fact should be available for impeachment of the witness, and impeachment would seem to be a form of *ad hominem*. Similarly, the rules of evidence allow the use of some sorts of bad character evidence for impeachment purposes.[34] On the other hand, in some circumstances, the courts have warned against the use of the *ad hominem*. In *United States v. Biasucci*,[35] the United States Court of Appeals for the Second Circuit found inappropriate the prosecutor responding to defense counsel by addressing the attorney as "you sleaze" and "you hypocritical son —" and describing counsel as "unlearned in the law."[36] The Supreme Court, in *United States v. Young*,[37] also called on both prosecutors and defense counsel to refrain from *ad hominems* directed against the other.

The difference between accepting *ad hominems* directed against witnesses but not against opposing counsel or the court is explained by the differing roles of witnesses, on one hand, and counsel or judges, on the other. The role of counsel is, in addition to questioning witnesses, the presentation of argument. That argument should stand or fall of its own power and an attack on the person offering the

34 *See* FED. R. EVID. 609 (use of prior conviction); FED. R. EVID. 608 (character for truthfulness or untruthfulness).

35 786 F.2d 504 (2d Cir. 1986).

36 *Id.* at 514 n.9.

37 470 U.S. 1 (1985).

argument is a fallacy. The judge, in issuing rulings on law, is in much the same position. The witness, on the other hand, offers evidence with regard to what has or has not occurred; the assertions are factual. The veracity of the testimony may be affected by bias or untrustworthiness, and pointing out that potential is not the invocation of a fallacious argument. In effect, the only way to evaluate the testimony of a witness is an evaluation of veracity. The evaluation of an argument by counsel or a decision by the judge should be based on the logic of the argument or the logic supporting the decision.

Most of the informal fallacies face similar questions in application to law,[38] but what of more formal logic? Here there would seem to be less reason to distinguish law from other fields. If logic has recognized certain forms of argument as valid, and a legal argument goes beyond or contradicts one of those forms, that would appear to be a solid reason for calling the validity of the argument into question. Here logic may be of service to the law, by identifying problems with arguments. Even here, however, it must be recognized that sometimes the seeming difference in logic may be nothing more than a linguistic difficulty, and that the law has come to the proper solution. Logic can also help law in finding the best language to express the rules adopted by legal institutions.

An example both of linguistic error and providing better phrasing of a rule is provided by an analysis I undertook of the evidence rules regarding the proof of a negative.[39] Evidence law asserts that it is difficult to prove a negative, and when a party is faced with such a burden, the burden should be shifted to the other party.[40] There is, however, nothing inherently difficult in proving a negative, so the rule of evidence would appear logically flawed. The situations in which it is more difficult to prove a negation do not have to do with the negation but with the difference in difficulty between proving universal and existential propositions in predicate logic. The universal, "for every x, A is true of x," is more difficult to prove than the existential, "there is an x, such that A is true of x." The existential is proved by identifying the x for which A is true. The universal requires either

38 *See* Kevin W. Saunders, *Informal Fallacies in Legal Argument*, 44 S.C. L. REV. 343 (1993). On informal fallacies, see generally RUGGERO J. ALDISERT, LOGIC FOR LAWYERS: A GUIDE TO CLEAR LEGAL THINKING (2d ed. 1992), and IRVING M. COPI & CARL COHEN, INTRODUCTION TO LOGIC (8th ed. 1990).

39 *See* Kevin W. Saunders, *The Mythic Difficulty in Proving a Negative*, 15 SETON HALL L. REV. 276 (1985).

40 *See, e.g.*, Walker v. Carpenter, 57 S.E. 461, 461 (N.C. 1907) ("The first rule laid down in the books on evidence is to the effect that the issue must be proved by the party who states an affirmative, not by the party who states a negative.").

examining all x's to see that A is true for each or reasoning to the conclusion that A must be true for all x's. The reason that the negative appears more difficult to prove in law is that a legal case is more likely to turn on an existential claim, and the negative of that claim is a universal.

Despite this apparent error, the judges have regularly identified instances in which a particular negative proposition was difficult to prove.[41] Those instances have been cases in which the negative was a universal. Where the particular negative was not so difficult, special rules have been adopted not requiring a shift in burden, such as in instances "where a particular fact necessary to be proved rests peculiarly within the knowledge of one of the parties."[42] In such instances the negative has been the negation of an unquantified proposition or the negation of a universal, which is an existential. The point is that, despite the appearance of an error in logic, the real difficulty was not in the outcomes but in the failure to recognize the real problem or attach the proper label. A judiciary better schooled in logic would have better stated the rule, but the lack of such schooling did not lead to incorrect results. The logician, in the tradition of Dewey, can study the successful shifting of burdens and find the rule that states the practice more simply than it had been stated by the courts. Rather than a shift, when faced with the burden of proving a negative with exceptions for situations where the negative is not difficult to prove, a rule shifting the burden when a party is faced with proving a universal is far more simply stated and more accurate from a logical point of view. Logic here has been of service to the law.

Logic can also be of service to the law in the drafting of statutes. Layman Allen[43] and others[44] have discussed logical form in that area and have attempted to identify the sources of ambiguity in statutes. Much of the ambiguity in statutes, and in other statements of the law, results from the misuse of logical connectives or the failure to recognize that it is unclear how portions of a complex proposition are to be

41 *See* Saunders, *supra* note 39, and cases cited therein.

42 Shumak v. Shumak, 332 N.E.2d 177, 180 (Ill. App. Ct. 1975).

43 *See* Layman E. Allen & C. Rudy Engholm, *Normalized Legal Drafting and the Query Method*, 29 J. LEGAL EDUC. 380 (1978); Layman E. Allen & Charles S. Saxon, *One Use of Computerized Instructional Gaming in Legal Education: To Better Understand the Rich Logical Structure of Legal Rules and Improve Legal Writing*, 18 U. MICH. J.L. REFORM 383 (1985); Layman E. Allen, *Plain Legal Drafting for the Electronic Age*, *in* COMPUTER SCIENCE AND LAW 75 (Bryan Niblett ed. 1980); Layman E. Allen, *Symbolic Logic: A Razor-Edged Tool for Drafting and Interpreting Legal Documents*, 66 YALE L.J. 833 (1957).

44 In addition to those who have worked and written with Professor Allen, *see supra* note 43, see Grayfred B. Gray, *Reducing Unintended Ambiguity in Statutes: An Introduction to Normalization of Statutory Drafting*, 54 TENN. L. REV. 433 (1987).

combined. To offer a technically ambiguous, but in practice clear, example, the rule "stop when school bus is loading and unloading children" admits of two readings. One of the readings, that one need stop only when some children are getting on and others are getting off, would seldom apply. The rule really should be phrased as "stop when school bus is loading *or* unloading children" or as "stop when school bus is loading children and stop when school bus is unloading children." A human reader understands the intent, but a computer application working with the statement would find some difficulty.

III. LAW, LOGIC, AND ARTIFICIAL INTELLIGENCE

There is a tie between the normal form for statutes espoused by Professor Allen and an area of potential future importance to law. Artificial intelligence has become a part of manufacturing and is important in various fields of inquiry.[45] Its potential for use in legal reasoning has been noted,[46] and expert systems, capable of applying the law to fact patterns have been developed.[47] Such a computerized system asks the user the relevant questions, applies rules to the information provided, and arrives at a legal conclusion. Learning to express the rules of law in normalized form helps in expressing the rules as required in one of the more common expert system programming languages.[48] Other approaches to artificial intelligence, neural net-

45 *See generally* MIKE SHARPLES ET AL., COMPUTERS AND THOUGHT: A PRACTICAL INTRODUCTION TO ARTIFICIAL INTELLIGENCE (1989); ALEXANDER E. SILVERMAN, MIND, MACHINE AND METAPHOR: AN ESSAY ON ARTIFICIAL INTELLIGENCE AND LEGAL REASONING (1993); Edwina L. Rissland, *Artificial Intelligence and Law: Stepping Stones to a Model of Legal Reasoning*, 99 YALE L.J. 1957 (1990).

46 For a discussion of some of the possibilities and some of the difficulties of developing systems of artificial intelligence in law, see RICHARD E. SUSSKIND, EXPERT SYSTEMS IN LAW (1987).

47 *See, e.g.*, Grayfred B. Gray et al., *Legal Expert System Building: A Semi-Intelligent Computer Program Makes It Easier*, 12 J. COMP. & INFO. L. 555 (1994); I.T. Hardy, *Creating an Expert System for Legislative History Research: Project CLEAR's "Lexpert,"* 85 LAW LIB. J. 239 (1993). I have also taught a seminar in expert systems in law in which law students, without a sophisticated background in computers, each developed an expert system for an area of law, using the VP-Expert shell program. An introduction to that shell program can be found in SYLVIA FRIEDERICH & MICHAEL GARGANO, EXPERT SYSTEMS DESIGN AND DEVELOPMENT USING VP-EXPERT (1989).

48 For an introduction to the programming language referred to, see JEAN B. ROGERS, A TURBO PROLOG PRIMER (1987).

works for example,[49] will also require logically unambiguous statements of legal rules.[50]

The study of logic by lawyers, law students and pre-law students should prove valuable in these areas. The resolution of the ambiguities found in statutes may be a matter of statutory interpretation, perhaps including an inquiry into legislative intent, that may not be pure logic. However, expressing the found intent of the statute requires a logically unambiguous combination of the terms interpreted. Here a logic trained lawyer is at an advantage. It is even more clear that an understanding of logic is required for artificial intelligence uses.

Professor Wesley Hohfeld, in his attempt to clarify the legal terms "right," "duty," "privilege," "no-right," "power," "immunity," "disability," and "liability," was motivated by a recognition that opaque language can stand in the way of legal understanding. He said, quoting an older evidence treatise:

> As our law develops it becomes more and more important to give definiteness to its phraseology; discriminations multiply, new situations and complications of fact arise, and the old outfit of ideas, discriminations, and phrases has to be carefully revised. Law is not so unlike other subjects of human contemplation that clearness of thought will not help us powerfully in grasping it.[51]

That observation is of even more importance today. As Professor Allen has noted:

> With the advent of the digital computer and the power of electronic information retrieval systems, the precise usage and definition of words rises from the level of merely aiding the efficiency of a transaction between legal entities to that of being virtually essential, where computers are involved, if the transaction is to take place at all. Man learns by example and possesses the creativity to resolve ambiguities; . . . machines are considerably less sophisticated than men in taking into account the relevant features of the total context

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49 *See* Michael Aikenhead, *The Uses and Abuses of Neural Networks in Law*, 12 SANTA CLARA COMPUTER & HIGH TECH. L.J. 31 (1996).

50 Logical ambiguity is different from the ambiguity present in many legal terms. Logical ambiguity is present when it is unclear how the concepts are to be combined into complex propositions or arguments. Even when the logical structure is clear, ambiguity or vagueness of terms may be present. An expert system employing such terms may still operate, but judgment will be required on the part of the user in answering the questions put by the computer.

51 Wesley N. Hohfeld, *Some Fundamental Legal Concepts as Applied in Judicial Reasoning*, 23 YALE L.J. 16, 29 n.25 (1913) (quoting JAMES BRADLEY THAYER, PRELIMINARY TREATISE ON EVIDENCE 190 (1898)).

> in dealing with problems. In general, a computer requires a clearer and more precise specification of the question to be resolved.[52]

The computer is a logical machine, and if legal analysis is ever to involve computers, not only the terms that concerned Hohfeld, but also the logical structure in which those terms can be combined and inferences drawn, must be developed.

While teaching logic to those involved in law is a step toward this goal, the difficulty in attaining this goal is the great complexity of any logic providing a structure capable of capturing the meaning of even basic legal concepts and the varieties of argument involved in legal reasoning. Legal reasoning is at times deductive and at times by analogy. The logic of deduction is well developed compared to the logic of analogy, but even the application of deductive logic, propositional, predicate, modal, and deontic logic, runs into difficulty over the complexity of the legal concepts involved. As an example of this complexity, consider the concept of a Hohfeldian power, the capacity to perform some act that creates or terminates a legal relation.[53] Building on a logic developed by Professor Allen[54] that provides a structure for the analysis of "right," "duty," "no-right," and "privilege," I extended the logic to work with the remaining Hohfeldian relations.[55] The definition provided there for "power" was

(SLRy)[~LRy&(Sa)[~Bax&M'Bax&~OBax &(Bax⇒LRy)]].[56]

The formula is read as, "There exists a legal relation of person y such that the legal relation of y does not hold, and there exists an act a, such that a has not been done by person x and it is naturally possible[57] that a can be done by x and it is not obligatory that a be done by x and if a were done by x, the legal relation of y would hold." While the reading would seem quite complex, the true complexity, and the number of unresolved issues in logic, are just barely hinted at by the formula.

The logic within which the above formula was expressed and could be logically combined with other propositions was built on a

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52 Layman E. Allen, *Formalizing Hohfeldian Analysis to Clarify the Multiple Senses of 'Legal Right': A Powerful Lens for the Electronic Age*, 48 S. CAL. L. REV. 428, 428–29 (1974).

53 *See* Hohfeld, *supra* note 51, at 44–45.

54 *See* Allen, *supra* note 52.

55 *See* Kevin W. Saunders, *A Formal Logic for the Analysis of Hohfeldian Relations*, 23 AKRON L. REV. 465 (1990).

56 *Id.* at 498.

57 Natural possibility is a stronger requirement than logical possibility. Logical possibility would require only that the act not be some sort of contradiction that, no matter what the world were like, could not be done. Natural possibility requires that the act can be done, consistent with the laws of nature.

propositional logic base, but recognized one of the difficulties of propositional logic. That difficulty is in capturing the natural language meaning of the "if p, then q" proposition. Propositional logic is based on a truth functional definition in which "p→q" is true, so long as it is not the case both that "p" is true and "q" is false. Logicians have long been dissatisfied with this treatment of conditionals, since the ordinary language use of conditionals seems to require some connection between the antecedent and consequent other than a relationship of truth values. This dissatisfaction has led to the development of modal logics[58] and relevance logics.[59] Professor Allen's system, underlying the formula, uses a relevance logic. If there were but one relevance logic, or one generally accepted as best capturing the meaning of conditionals, the inclusion of that logic would make the system more complex but would not inject any controversy. However, there is not such agreement on relevance logic, and such logics are the topic of current research.[60] Until relevance logic is adequately developed, there may be questions over the logical treatment of conditionals in legal argument.

The logic also has to have the axioms required to handle predicate logic. In fact, since the formula above contains quantification over both individual persons and over relations, it must be a second order predicate logic.

The "M" in the formula requires that the logic also contain modal logic, a logic capable of handling necessity and possibility, as well as truth and falsity. Again, while the inclusion of such a logic adds to the complexity of the system, the real difficulty is in deciding which modal system to include.[61] While Professor Allen and I built our systems on a modal system that is not controversial with regard to what can be

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58 *See infra* notes 61–62 and accompanying text.

59 For one of the earlier detailed considerations of the issue, see ALAN ROSS ANDERSON & NUEL D. BELNAP, JR., ENTAILMENT: THE LOGIC OF RELEVANCE AND NECESSITY (1975). Relevance logics require some conceptual connection between the antecedent and consequent of a conditional.

60 *See, e.g.*, Josep Maria Font & Gonzalo Rodriguez, *Algebraic Study of Two Deductive Systems of Relevance Logic*, 3 NOTRE DAME J. FORMAL LOGIC 369 (1994); Mark Lance & Philip Kremer, *The Logical Structure of Linguistic Commitment II: Systems of Relevant Commitment Entailment*, 25 J. PHIL. LOGIC 425 (1996); Francesco Paoli, *Semantics for First Degree Relatedness Logic*, 27 REP. MATHEMATICAL LOGIC 81 (1993); Greg Restall, *Four-Valued Semantics for Relevant Logics (and Some of their Rivals)*, 24 J. PHIL. LOGIC 139 (1995).

61 For a general discussion of modal logic and various systems of modal logic, see D. PAUL SNYDER, MODAL LOGIC AND ITS APPLICATIONS (1971), G.E. HUGHES & M.J. CRESSWELL, AN INTRODUCTION TO MODAL LOGIC (2d prtg. 1972) and CLARENCE IRVING LEWIS & COOPER HAROLD LANGFORD, SYMBOLIC LOGIC (1932).

derived, it is a system that may be too weak for artificial intelligence purposes. The weaker, less controversial, modal systems allow the possibility of strings of modal operators, the "M" of possibility or the "L" of necessity, to build up. In the human generated proofs of Allen's and my work that did not occur, but with a computer manipulating formulas, perhaps with more randomness and less view toward a particular goal, such strings might develop.

Stronger modal systems allow the derivation of simpler strings from long strings. The early attempts at developing such systems resulted in the system S4, which allowed all strings to reduce to one of the following: "p," "Lp," "Mp," "LMp," "MLp," "LMLp," "MLMp," or the negation of one of the foregoing, and S5, in which all strings reduce to the last modal operator in the string. S4 is viewed as too weak, given the strings that remain, and S5 is too strong, since anything that is possibly necessary turns out to be necessary. Dissatisfaction with both systems has led to the development of systems with a strength between the two,[62] but again there is no consensus on the best modal system, and that dispute will be incorporated into any debate over the best system for use in artificial intelligence and law.

The formula also contains the operator "O," which requires a system of deontic logic that considers obligation and permission. Deontic logic is itself an area of ongoing research,[63] and any difficulty or disagreement in that area will carry over to a logic capable of capturing basic legal concepts.

Lastly, the "⇒" in the formula does not represent the standard conditional. It is instead the counterfactual conditional; that is, "p⇒q" is read as "if p were the case, then q would be the case." The logic must differ from material implication, the usual "p→q," since it is used when p is not the case, and when "p" is false, "p→q" is always true. The representation of Hohfeld's relations then requires a logic

62 The systems are between S4 and S5 in the sense that any theorem of S4 can be proven in the system, and the system can be used to prove additional theorems, all of which are theses in S5, but cannot be used to prove all the theses of S5. For a discussion of some of the systems between S4 and S5, see HUGHES & CRESSWELL, *supra* note 61, at 260–64. There are also systems weaker than S5, in that they contain some but not all of the theorems of S5, but not as strong as S4, in that they do not contain all the theorems of S4; as well as systems stronger than S4 but not contained in S5, in the sense that they contain theorems that cannot be proven in S5. *See id.* at 264–67.

63 *See, e.g.*, INTERNATIONAL WORKSHOP ON DEONTIC LOGIC IN COMPUTERSCIENCE, DEONTIC LOGIC, AGENCY AND NORMATIVE SYSTEMS (Mark A. Brown et al. eds., 1996); Mark A. Brown, *A Logic of Comparative Obligation*, 57 STUDIA LOGICA 117 (1996); Lou Goble, *'Ought' and Extensionality*, 30 NOUS 330 (1996); John F. Horty, *Agency and Obligation*, 108 SYNTHESE 269 (1996); Edwin Mares, *Andersonian Deontic Logic*, 58 THEORIA 3 (1992).

of counterfactual conditionals.[64] Again, there is not general agreement over what that logic should be,[65] and again that disagreement will carry over to the logic necessary for artificial intelligence and law.

The difficulties discussed so far are only those present in analyzing the deductive aspects of legal logic and making them amenable to artificial intelligence. Perhaps an even greater challenge is presented by the fact that much of legal argument is not deductive but is instead argument by analogy.[66] The internal working of an expert system based on deductive logic is relatively simple compared to a logic for analogy. Indeed, it might even be questioned whether analogy is a form of logic. Professor Cass Sunstein describes the form of argument by analogy as being "(1) A has characteristic X; (2) B shares that characteristic; (3) A also had characteristic Y; (4) Because A and B share characteristic X, we conclude what is not yet known, that B shares characteristic Y as well."[67] Professor Scott Brewer has a similar definition based on more instances than A and more shared characteristics than X.[68] The form is similar, but the greater number of instances in which X has been accompanied by Y, and the more characteristics shared by A and B, increase the force of the analogy.

The argument form, as characterized by Sunstein, is obviously not a form of deductive logic. It might be questioned whether it is logic at

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64 *See generally* DAVID LEWIS, COUNTERFACTUALS (1973).

65 The system in Saunders, *supra* note 55, includes a logic for counterfactuals presented in JOHN L. POLLOCK, SUBJUNCTIVE REASONING (1976). That system is weaker than the system in LEWIS, *supra* note 63. If the treatment of counterfactuals proves not to be sufficiently powerful for working with Hohfeldian relations, there will be an issue over how strong to make the system.

66 For discussions of the role of analogical reasoning in law, see Cass R. Sunstein, *On Analogical Reasoning*, 106 HARV. L. REV. 741 (1993), and Scott Brewer, *Exemplary Reasoning: Semantics, Pragmatics, and the Rational Force of Legal Argument by Analogy*, 109 HARV. L. REV. 925 (1996).

67 Sunstein, *supra* note 66, at 743.

68 Professor Brewer explains the form as follows:

> Where *x*, *y*, *z* are individuals and F, G, H, are predicates of individuals:
>
> *Step 1:* *z* has characteristics F, G, . . .
>
> *Step 2:* *x*, *y*, . . . have characteristics F, G, . . .
>
> *Step 3:* *x*, *y*, . . . also have characteristic H.
>
> *Step 4:* The presence in an individual of characteristics F, G, . . . *provides sufficient warrant* for inferring that H is also present in that individual.
>
> *Step 5:* Therefore, there is sufficient warrant to conclude that H is present in *z*.

Brewer, *supra* note 66, at 966 (footnote omitted).

all,[69] since experience with deductive logic leads to the expectation that logical conclusions follow with certainty, a certainty lacking in analogical reasoning. It is interesting that Professor Brewer likens analogy to abduction, a principle that holds that if X occurs, and Y would explain the occurrence, there is reason to accept Y.[70] However, the same complaint could be offered against abduction. Nonetheless, if analogy is a successful form of argument, then with Dewey, it should be accepted as a part of the study of logic despite its lack of deductive surety. Furthermore, it is clear that analogy is both a successful and necessary part of legal argumentation. Professor Sunstein calls analogical reasoning "the most familiar form of legal reasoning,"[71] and Professor Brewer calls it legal argument's "own distinct method."[72] The entire working of the common law is based on analogy. Case A has been decided, case B is like case A in certain relevant facts, therefore the result in case B should be the same as that in case A.

The importance of analogical reasoning to legal argument, the claim that it is even the hallmark of legal argument, make it clear that for artificial intelligence to be applied to law, the workings of analogical argument must be explicated with sufficient clarity so as to allow a computer to draw proper analogical conclusions while avoiding unwarranted conclusions. There are, in fact, attempts to replicate analogical reasoning in artificial intelligence applications to law. Some early work in the area was that of Professor Thorne McCarty,[73] but more recent efforts have been by Professor Kevin Ashley.[74]

Professor Ashley's program *HYPO* is an attempt to model the use of precedent in case based argument. *HYPO* includes a knowledge base of cases in trade secret law. If the program is supplied with a set of facts, including the positions of the two parties to a suit, it searches for the cases most on point supporting the potential outcomes. *HYPO* also distinguishes the precedents by searching for facts in the precedent that are not present in the case at issue.

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69 Professor Sunstein notes the unwillingness on the part of some to accept analogical reasoning as even being a form of reasoning. *See* Sunstein, *supra* note 66, at 741.

70 *See* Brewer, *supra* note 66, at 947–48, 962.

71 Sunstein, *supra* note 66, at 741.

72 Brewer, *supra* note 66, at 926.

73 *See* L. Thorne McCarty, *Reflections on TAXMAN: An Experiment in Artificial Intelligence and Legal Reasoning*, 90 HARV. L. REV. 837 (1977).

74 KEVIN D. ASHLEY, MODELING LEGAL ARGUMENT: REASONING WITH CASES AND HYPOTHETICALS (1990). Ashley's work is also described in Rissland, *supra* note 45, at 1971–73.

While *HYPO* is an impressive effort at modeling legal reasoning, there are limitations. Certainly, if a case is on all fours with a precedent in the knowledge base, a result can be generated. It is even possible to assign weights to particular varieties of facts, so that an analogical reasoning program can do more than simply count points of similarity, or assign additional or less weight, when particular facts differ in degree. For example, when the precedent case was based on a threshold monetary value, a greater value might require that greater weight be given to any implications to be drawn from facts involving monetary value.[75]

Problems with the model may arise, however, from the limitations on the knowledge base. The base is trade secret law, so analogies can only be drawn from that area. That would usually be the proper base for a trade secret law decision, but sometimes an analogy might be drawn from another area of the law. Perhaps it will be a copyright case that provides the most important precedent. At least in difficult cases, while guidance is first drawn from precedents in the same area of the law, there may be instances where the most forceful analogies are to be drawn from another area of the law.[76] Identifying those instances may require an analysis of the policies behind the rules laid down by the precedents. *HYPO* is not able to bring into the argument those policy concerns.

Analogical reasoning is simply a difficult area to capture logically. As Professor Brewer says, "There is an art to making apt, instructive, compelling analogies."[77] While he maintains that there is also a logic to the task,[78] that logic is difficult to characterize. Brewer does attempt to do so, stating:

> [I]n order for an argument by analogy to be compelling—to have . . . rational force—there must be sufficient warrant to believe that the presence in an "analogized" item of some particular characteristic or characteristics allows one to infer the presence in that item of some particular other characteristic. It is this sufficient warrant that I have labeled 'analogy warranting rule.' An analogy warranting

75 Rissland, *supra* note 45, at 1972 n.70, describes the use, in *HYPO*, of disparity between plaintiff's and defendant's development costs, suggesting that where a two to one ratio has been sufficient to recover, a four to one ratio should add strength.

76 Professor Dworkin allows for local priority in case law reasoning but suggests that there are times when the judge should look for fit between cases by progressing through a series of concentric circles of cases. Where local priority matches moral principles, it is important, but where the boundaries that mark out the local are mechanical and arbitrary, there is less reason to be limited to the local cases. *See* RONALD DWORKIN, LAW'S EMPIRE 250–53 (1986).

77 Brewer, *supra* note 66, at 964.

78 *See id.*

> rule states the *logical relation* between those characteristics of compared items that are known to be shared and those that are inferred. Another important component in a compelling argument by analogy is what I have called the 'analogy warranting rationale'. . . . [R]ationales stand to rules in the two closely associated relations of explanation and justifications—that is, rationales explain and justify rules.[79]

The problem is with the "logical relation" between the characteristics shared and those inferred. That relationship must not be sufficiently strong so as to logically entail the conclusion, or the reasoning would not really be analogical. It would instead be a predicate logic argument of the form "for all x with properties A, B, C, x also has property D. Individual y has properties A, B, C. Therefore, y has property D." The "logical relation" must be something weaker, and the relation would seem difficult to capture in logical form. Additional work in the logical analysis of analogical reasoning will be required.[80]

There would then appear to be two areas in which logic must develop to be of service in the effort to apply artificial intelligence to law. More work is required on the deductive aspects of legal reasoning because systems within which to manipulate the logically sophisticated concepts of law must be developed. Secondly, the logic of analogical reasoning requires further examination, since it is so important to legal reasoning. Neither of these tasks will prove to be simple.

IV. CONCLUSION

This symposium celebrates the publication of a book in logic and law. That is an important step. Few have been exposed to the subject in any depth. There are certainly logicians looking at law, but there are relatively few scholars, many of whom were taught by or worked with Layman Allen, who have the insights that training in both logic and law can bring. The exposure of pre-law students, or law students, to logic helps to address some of the issues I have raised. Those who have training in both areas will recognize the misuses of logic and will be more able to analyze the validity of legal argumentation.

Of course, a deeper understanding of the two fields is required to advance legal logic in the directions indicated. The exposure of stu-

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79 *Id.* at 965 (footnote omitted).

80 The work of Kevin Ashley, *see supra* note 73 and accompanying text, is such an effort. *See also* DOUGLAS HOFSTADTER, FLUID CONCEPTS AND CREATIVE ANALOGIES: COMPUTER MODELS OF THE FUNDAMENTAL MECHANISMS OF THOUGHT (1995)

dents to the basics of logic and law is a step, because some of those students may become sufficiently interested to study the area in more depth. A larger community of scholars can provide the interaction and support necessary for progress. Interaction between law schools and logic or computer science departments, including joint appointments, LL.M. or S.J.D. programs for legal academics interested in learning legal logic and doctoral or post-doctoral opportunities for logicians and computer scientists interested in increasing their understanding of law might be encouraged. It is training in both fields or cooperation among scholars in both areas that will assure that logical developments in the area are more than interesting exercises for logicians but are also of practical value to law and lawyers.