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SAVING US FROM OURSELVES: THE INTERACTION OF LAW AND SCIENCE-TECHNOLOGY*

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INTRODUCTION

MUCH of the furor about technology centers around the morality of focusing on profit margins and thereby permitting external costs to be transferred to the society in general, without the informed consent of those who must finally bear the cost. This internal assessment, even in this period of manifest social concern, emphasizes the calculus of the "economic cost-benefit ratio," with little concern for the consequential damages hidden in the external "social cost-social benefit ratio."[1] It is these societal costs which disrupt social order and undermine political and judicial stability. One of the best (and perhaps most overused) examples of technology as an agent of social disruption is the automobile. It is blamed for changes in social mores, for occasioning the death of the downtown core-city, and the rise of the suburb. Most of the social impacts registered by the automobile were, I am sure, neither intended by Henry Ford, nor were most of them even foreseeable, given the state of knowledge that existed in the early 1900s.

Clearly, to fully appreciate the problems posed by the introduction of technological innovations, such as the automobile into society, one must look behind the decision theory used to evaluate the suitability of a product or service for the public market.

I. LEGAL PROCESS AND SCIENCE-TECHNOLOGY

Change brought about by technology must be managed in such a way as to minimize the adverse effects prospectively, before harm accrues.[2] Thus, maintenance of social stability against the impact of

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[1] Coase, *The Problem of Social Cost,* 3 J. LAW & ECON. 1 (1960); *see also* Nutter, *Coase Theorem on Social Cost: A Footnote,* 11 J. LAW & ECON. 503 (1968). Economists call these costs "external diseconomies," which are defined as: a generally nonpurposeful byproduct of producing one commodity which raises the monetary cost of producing or consuming another commodity.

[2] The process of identifying the second-order effects of technology is called "technology assessment." The definition seems to have assumed sufficient breadth to include implementation of social control, as well as the scientific and engineering approaches to identification of second-order effects: "The concept of 'technology assessment' represents an attempt to understand and appraise the results of technological progress in order to allow the development of policies for the rational application of technology." Technology Assessment at v (R. Kasper ed. July 1969, Proceedings of a Seminar Series at George Washington University).

science-technology requires that we identify and promote, along with the primary beneficial consequences, the *desirable* second-order consequences; and reduce to a practical minimum those second-order consequences that are unintended, unanticipated, and undesirable.[3]

Three social institutions presently serve ad hoc roles in technology assessment: (1) market; (2) courts; and (3) legislatures.[4] Generally, the market has failed to give any indication of being a viable assessment agency. The public persists in demanding consumer goods with little concern for inherent dangers or longrange hazards; moreover, the public seems unwilling to pay higher consumer prices to abate the hazards. Failure of the market in its assessment role is attributable partially to the consumer's failure to recognize potential hazards and secondary consequences, and partially to an unconscious awareness that the social costs (external diseconomies) fall upon the general public and therefore do not directly affect the specific group or person who purchases the fruits of the technology.[5] A unique exception to this statement is liability insurance which in some ways tends to soften the effect of one of the inherent secondary consequences by spreading the cost of potential risks over a series of periodic payments and limiting these costs to the specific consumer group. It also serves as market assessor of technology. Premium rates reflect the insurance companies' willingness to assume the risks for the activity; therefore, if premiums are excessive or if the risks are so great that insurance is not available for the activity, it will operate to encourage an assessment of the factors causing the high risk.[6]

Courts have traditionally served as the *primary* instrumentality for internalizing the social costs resulting from socially irresponsible acts. Through the application of common law tort doctrines, the judiciary redistributes the social cost by placing financial liability upon those responsible for the injury, thus, it operates directly upon the incidents of costs.[7] The effectiveness of common law doctrines as instrumentalities of technology assessment has waivered with the laws' reflection

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[3] R. BAUER, SECOND-ORDER CONSEQUENCES 6 (1969).

[4] Green, *Technology Assessment and the Law: Introduction and Perspective,* 36 GEO. WASH. L. REV. 1033, 1035-37 (1968).

[5] Hardin, *The Tragedy of the Commons,* 162 SCIENCE 1243 (1968); The process of transferring social costs to the general public is described by Hardin in an analogy to the use of the Common by herdsmen. By placing one additional animal in the Common, a herdsman will gain the productivity of one animal, and because the cost for the production of this additional animal is distributed among all of the herdsmen of the Common, the socially irresponsible herdsman always gains more than it costs him as an individual. The tragedy of the Commons occurs, of course, when the herd exceeds the carrying capacity of the range.

[6] James, *Accident Liability Reconsidered: The Impact of Liability Insurance,* 57 YALE L. J. 549 (1948).

[7] Katz, *The Function of Tort Liability in Technology Assessment,* 38 U. CIN. L. REV. 587 (1969); Portnoy, *The Role of the Courts in Technology Assessment,* 55 CORNELL L. REV. 861 (1969).

of societal attitudes toward technology. The strict liability doctrine of *Rylands v. Fletcher*[8] gave way to less harsh nuisance doctrines, which required a showing of negligence, when the economic benefits of a rapidly expanding *laissez-faire* industrial society were realized at the turn of the century. As a result of recent public concern for environmental problems, nuisance doctrines are presently showing a trend back toward a position closer to strict liability.

A contemporary example of the role of common law as a force in technology assessment is demonstrated by the dynamic law of products liability. The grounds upon which manufacturers of automobiles will be found liable for design defects have been expanded from negligence to breach of implied warranty, and strict tort liability. There is neither data available to ascertain the financial impact which design suits have had on the industry, nor is it possible to evaluate the role of judicial process as a public mechanism to control automobile design, but greater public awareness of design litigation heightens the possibility that the corporate conscience will respond.[9]

Evolution of common law doctrines is extremely slow by modern standards, and as we shall see later on, technology has a tendency to out-pace its assessor. Furthermore, the chronic, insidious damage emanating from modern technology mocks traditional doctrines which require showing of harm and proximate causation. Finally, standards established by courts on the basis of cases and conflicts presuppose that the harm is already done — "Law is the articulation of the answers of yesteryear."[10]

In the legislative arena there evolves a merger of law and politics. This interaction between demonstrative public concern (politics) and judicial doctrines results in statutes and administrative regulations predicated upon, at least in theory, the balance of social benefits and social risks.

Legislative process does not require the presentation of a case or conflict for statutory enactment, thus it may be applied prospectively in anticipation of a societal problem. This fact coupled with the fact that most statutory law is applied by administrative agencies, provides flexibility and makes legislation seemingly the most effective vehicle for technology assessment presently available.

Notwithstanding the legislature's unique capability to implement legal process to protect the health, morals, safety, and general welfare of the public, it too fails as an assessment institution. In most cases, legislatures like courts, act after the fact. Seldom does a preliminary

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[8] L.R. 3 H.L. 330 (1868).

[9] Nader & Page, *Automobile Design and Judicial Process*, 55 CALIF. L. REV. 645 (1967).

[10] Miller, *Science vs. Law: Some Legal Problems Raised by "Big Science,"* 17 BUFFALO L. REV. 591, 593 (1968).

assessment of technology motivate the legislature to enact legislation; it is only after an obvious social problem arises and the issue becomes politicized that legislative action is taken. There is often a lag between identification of a social problem and its legislative solution in order for the public to become concerned enough about the problem to generate the political response needed to overcome legislative inertia. More telling is the fact that legislatures are structured for the mechanics of making laws of generality with which to deal with broad social problems; they are not equipped to handle the specificity required to evaluate the second-order effects of science-technology. If the market, the courts, and the legislatures are unable to adequately fulfill this task of technology assessment, how can it be done?

II. THE NEED FOR NEW INSTITUTIONS

The present federal agency structure divides the responsibility for science-technology assessment among numerous agencies, each limited by well-defined mission boundaries. No single governmental agency now possesses the broad authority or resources needed to evaluate the problems of science-technology in the broad context of its potential impact on the social and physical environment. A cursory look at some of the current problems which have been the result of technological innovation should serve as a substantial impetus in driving lawyers, scientists, politicians, and educators to press for a new institutional arm.

During the last 20 years computing technology has developed from highly specialized scientific application to general use. Considering the basic question of admissibility of computer output as evidence, the fact that records in machine language cannot be read directly by the court raises a potential problem with the hearsay rule. Courts have thus far fitted computer printouts into the business records exemptions of the hearsay rule although such records are intrinsically secondary evidence.[11] Questions concerning the availability of computer records have also arisen in application of discovery efforts in rules of procedure.[12] Additionally, computer software inventions present new and unique problems of protecting this kind of intellectual and industrial property under the established system of copyright law.[13]

One can speculate on the far-reaching impacts that mechanical innovations might have on society, and consequently the potential

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[11] Lowman, *Evidence: The Admissibility Of Computer Print-Outs In Kansas*, 8 WASHBURN L. J. 332 (1969); *see* Transport Indemnity Co. v. Seib, 178 Neb. 253, 132 N.W. 2nd 871 (1965); *cf.* Louisville & Nashville R.R. Co. v. Knox Homes Corp., 343 F.2nd 887 (5th Cir. 1965).

[12] Local 743, IAM v. United Aircraft Corp., 220 F. Supp. 19 (D.C. Conn. 1963), *aff'd* 337 F.2d 5 (2nd Cir. 1964), *cert. denied,* 380 U.S. 908 (1965).

[13] Koller, *Computer Software Protection: Report of an Institute Clinic,* 13 IDEA 351 (1969).

interaction with law as both a remedial tool and regulatory mechanism. But the more difficult problems will be those created by biological innovations. Professor Rene Dubos has observed that "the ethical issues created by modern biology [originate] from the necessitated course of two complementary aspects of human life: the right of the individual person, and the needs of the community from which he derives his physical and mental sustenance."[14] The balancing of personal freedom against societal interest is not a new challenge to legal process; but biomedical technology impinges upon *sanctum sanctorums* — the body, the mind, and the family. The conflict is with what one might consider a vested personal right to reap the benefits of biomedical science and the secondary consequences that broad scale application of such a vested right might have on society.

Consider both the recent application of biomedical innovations in human tissue transplantations, and the issue of artificial insemination. There can be no heart transplant until the donor has achieved a total state of death unless medicine commits murder. This leads directly to medical and ethical problems concerning: What is death? How is death defined? What is the difference between legal death and medical death? Exactly when does death occur so that a donation may be made?[15] Correlative legal technicalities associated with tissue transplantation are: Who has the right to determine whose heart will be used for a transplant? Can a prospective donor determine the use of his organs before he dies? If so, how long in advance of death need this decision be made? Can a surviving spouse or heirs of a decedent make this decision? What happens in the event that the decedent and his survivors have different ideas about what should be done with his remains? Who owns the cadaver? A short time ago the term "death" had a single meaning which was capable of definition. Now, in the light of current medical reality and the need for prompt removal of organs for transplantation, the moment of death is less capable of definition. There is the most extreme state of death: cytological death, meaning extinction of every living cell. There is physiological death, meaning cessation of vital functions. There is intellectual death, the inability to synthesize or assimilate knowledge. And there is also spiritual death, theological death, and social death.[16]

Similarly, the introduction of artificial insemination by donors as an alternative for marriage partners suffering from male sterility has had an unsettling effect on some familial relationships. Courts have been asked to decide on the legitimacy of offspring conceived in such man-

[14] *Seminar, The New Biology and the Law,* 2 U. FLA. L. REV. 427, 431 (1969).

[15] Wechter & Aranson, *Medical-Legal Ramifications of Human Tissue Transplantation,* 18 DEPAUL L. REV. 488, 489 (1969).

[16] *Seminar, supra* note 14, at 435.

ner, whether insemination is tantamount to adultery, and the inheritance rights of the offspring.[17]

The resolution of these problems must finally evolve from the collaborative thinking of scientists, physicians, lawyers, theologians, and philosophers. Biochemical developments on the horizon will raise more complex questions.

At this point one must distinguish science from technology, for it is this distinction wherein part of the root of the problem lies. Technology is applied science.[18] Therefore, the gestation period between the evolution of scientific discovery and the development into a marketable technology is a potential period of intellectual introspection, during which research, debate, and speculation about the potential problems of applying the fruits of the discovery can develop. Time lags between scientific discovery and technological application continue to get shorter (Table 1.).[19] Ways are constantly being sought to reduce the technological lag because of obvious economic implications.[20] This period of lead time is precious for in-depth assessment, yet it will continue to be shortened to its minimum practical limit by the technologists.

TABLE 1.

Time Lag Between Product Discovery and Application

Innovation	Year of Discovery	Year of Application
Electric Motor	1821	1886
Vacuum Tube	1882	1915
Radio Broadcasting	1887	1922
X-ray Tubes	1895	1913
Nuclear Reactor	1932	1942
Radar	1935	1940
Atomic Bomb	1938	1945
Transistor	1948	1951
Solar Battery	1953	1955
Stereospecific Rubbers & Plastics	1955	1958

Ad hoc assessment of technology by the traditional governmental and private institutions discussed above involves a significant time lag between recognition of the problem and implementation of controls.[21] The momentum of science and technology, coupled with

[17] Guttmacher, *Artificial Insemination,* 18 DEPAUL L. REV. 566 (1969).

[18] WEBSTER'S SEVENTH NEW COLLEGIATE DICTIONARY 905 (1969).

[19] Wolfbein, *Pace of Technological Change and Factors Affecting It* 19 (paper presented at the North American Regional Conference on Manpower Implications of Automation, Wash., D. C., Dec. 1964).

[20] PREHODA, DESIGNING THE FUTURE 89 (1967).

[21] Daddario, *Technology Assessment — A Legislative View,* 36 GEO. WASH. L. REV. 1044, 1049-50 (1968).

potential harm which modern developments can suffer upon society, mitigates against the ad hoc approach to technology assessment. A number of alternative institutions have been proposed to serve the necessary governmental functions.[22] There is a diversity of opinion as to the specific role such an institution should play in regulation of technology, the mechanics of implementation and to whom it should answer, but it is generally agreed that the assessment institution must have a significant research component at its disposal.[23] To be effective the assessment institution must be staffed heavily by natural scientists and engineers, with a significant complement of social scientists to consider the economic, behavioral and political ramifications. Whatever form the institution takes, it must be innovative in its approach to assessment. By definition, it must be broadly multidisciplinary and structured to maximize the interaction among specialists. It will be unique enough among science-technology institutions in that no exact prototype exists today.[24]

III. The Lawyer and Legal Process in Technology Assessment

It is implicit from the foregoing that the legal process plays an important role in technology assessment; but just what is that role? I must disagree with Chief Justice Burger in his view that "[t]he law's assignment in society is not one to anticipate needs. The law responds after a problem arises, and that is as it should be."[25] I prefer to adopt the thesis that law, being normative in nature, must also be expanded to include law that is goal-seeking; in short, it must be neutral; it must be "result" or "future oriented."[26] This implies a responsive, dynamic law — a law which participates at all stages of the science-technology assessment process. Given this position on the scope of the law, exactly what is the lawyer's role, and when does he enter into the assessment procedure? Although the lawyer is not uniquely vested with infinite wisdom to formulate the proper question, legal

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[22] NATIONAL ACADEMY OF SCIENCES, 91ST CONG., 2D SESS., TECHNOLOGY: PROCESS OF ASSESSMENT AND CHOICE (House Comm. on Science & Astronautics, Comm. Print 1969); COMMITTEE ON PUBLIC ENGINEERING POLICY, NATIONAL ACADEMY OF ENGINEERING, 91st CONG., 2d SESS., A STUDY OF TECHNOLOGY ASSESSMENT (House Comm. on Science & Astronautics, Comm. Print 1969); Ecological Society of America, *National Institute of Ecology: An Inquiry?* (March 25, 1970); ENVIRONMENTAL STUDIES BOARD, NATIONAL ACADEMY OF SCIENCES — NATIONAL ACADEMY OF ENGINEERING, INSTITUTIONS FOR EFFECTIVE MANAGEMENT OF THE ENVIRONMENT, pt. 1 (1970).

[23] Kiefer, *Technology Assessment*, CHEMICAL AND ENGINEERING NEWS, Oct. 5, 1970, at 42.

[24] AD HOC NEL CONCEPT COMMITTEE, OAK RIDGE NATIONAL LABORATORY, 91ST CONG., 2d SESS., THE CASE FOR NATIONAL ENVIRONMENTAL LABORATORIES 15-16 (Senate Comm. on Public Works, Comm. Print 1970).

[25] *Seminar, The New Biology and The Law,* 21 U. FLA. L. REV. 427, 433 (1969).

[26] Miller, *Science vs. Law: Some Legal Problems Raised by "Big Science,"* 17 BUFFALO L. REV. 593, 602 (1968).

training does sensitize one to social problems and humanistic values which must be considered before the questions are posed. This is essential since once cannot get correct answers without first posing the correct questions.[27] The importance of posing the proper questions in technology assessment assumes perspective if you consider the queries: How much noise can a human tolerate, compared to, how noiseless can the machine reasonably be made? I suggest that you would arrive at widely divergent answers from assessment of the same technology merely by approaching the problem from contrasting positions posed by the two questions.

The lawyer's role is better defined later in the assessment process when the attributes of the technology are known and appropriate control is being considered to protect basic individual rights. Implementation of control should remain in the hands of the legislature to weigh the facts against public policy considerations. How the technical data and alternatives are presented to the legislative body, and the procedural aspects of the policy formation are both aspects of the process which will rely heavily on the legal profession.

It has been suggested that the weighing of public risks (costs) versus public benefits cannot be entrusted to an elite group, a panel or board acting *ex cathedra*; but rather the public itself must express its views through its elected representatives in the democratic process. How then is the information communicated simultaneously to the public and the legislature to begin policy formulation? Professor Harold P. Green suggests that the adversary process offers a potent vehicle "to compel scientists and technologists to present the issues to the public in the language of ordinary public discourse rather than in the esoteric jargon of their disciplines."[28]

An adversary procedure would give equal time and attention to the negative factors of technology as well as the positive factors emphasized by the vested interests. This approach is not without its detractors however. Discussion concerning the application of the adversary process to information transfer within a technology assessment institution invariably reveals an aversion among scientists to participate in a procedure which centers upon advocacy.[29] Most scientists would apparently opt for an "objective institution" as opposed to an "adversary institution," thereby failing to recognize that advocacy can also be objective-like in its *final* result.

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[27] *See* Estate of Rogers v. Commissioner, 320 U.S. 410 (1943). "In law also the right answer usually depends on putting the right question." *Id.* at 413.

[28] *See* SUBCOMM. ON SCIENCE, RESEARCH AND DEVELOPMENT, HOUSE COMM. ON SCIENCE AND ASTRONAUTICS, 91ST CONG., 1ST SESS., TECHNOLOGY ASSESSMENT 175 (Comm. Print No. 13, 1969).

[29] Kasper, *supra* note 2, at 79.

IV. Problems of Communication

The behavioral divergence with regard to advocacy is but one of the attitudinal impediments which must be overcome between scientists and lawyers in a multidisciplinary effort such as technology assessment. Another equally important problem is: How do we structure an institution capable of handling the complex task of creating a highly interactive, multidisciplinary organization which I discussed above? It is implicit that there must be the intellectual capacity to staff such an institution. Earlier I mentioned the apparent attitudinal differences between scientist-engineers and lawyers; since communication among the disciplines is the key to an effective assessment institution, it is beneficial to look at some of the differences between the professions. Scientific method involves the formulation of theories by inductive logic gained from empirical observations, which are then tested by experimentation, reformulated, tested again and verified. The output is reputed to be arrived at scientifically, ergo "dispassionately," "objectively," and "unbiased." The "logico-inductive" process is the backbone of science; the facts and theories thus derived must survive a period of critical study and testing by other competent and disinterested individuals, and must be found so persuasive that they are almost universally accepted. John Ziman observed in a comparison of science and nonscience, that:

> We all feel that legal thought is quite different from scientific thought — but what is the basis of this intuition? There are many ways in which legal argument is very close to Science. . . . To the extent . . . that the Law is strictly logical, it can be made "scientific" . . . . But, of course, in Science, when the evidence is conflicting, we withhold our assent or dissent, and do the experiment again. This cannot be done in legal disputes, which must be terminated yea or nay. . . . The Law is thus unscientific because it *must* decide upon matters which are not at all amenable to a consensus opinion.[30]

A most important philosophical distinction between science and law is the power to discriminate between what is consensible and public in a scientific sense, and what is not. The frustrations of a lawyer are understandable when his scientist-colleague refuses to make categorical statements concerning factual observations. Science depends heavily upon statistical inference to create the consensual acceptance of proven theories. Physics represents, perhaps, the "purest" of science; it is deterministic and can be reduced to mathematical terms with high predictability. Statistical probabilities associated with many experiments in the physical sciences will exceed 99 percent, the difference between prediction and perfection being due to random experimental error. Biological and behavioral sciences, on the other hand, have low probabilities associated with their predictability, and must, therefore, depend

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[30] J. Ziman, Public Knowledge 13, 15 (1968).

heavily on statistical inference. The natural systems with which we are compelled to work in environmental and sociological studies are characteristically variable; thus, observations made thereon are less reliable. Predictions under those circumstances are considered quite good if they are correct 60 percent of the time. The point being that science measures the value of a theory by the ability to reproduce results with sufficient predictability to elicit a consensus of agreement among professional colleagues. The tendency is to make further observation and experiments to improve the reliability of the prediction so as to persuade other people to agree to the consensus.

> Our first care in Science, is to preserve the consensus from unwitting error; what is certain must be clearly delineated from what is conjectured; the continuous incorporation of merely probable results must inevitably lead to a degradation of the credibility of the whole scientific enterprise.[31]

Law deals with normative principles and moral issues which are quite outside of science. The business of law cannot be consensual in the same respect as science. "Science cannot tell us what *ought* to be done; it can only chart the consequences of what *might* be done."[32] Recognition of these distinctive and complementary roles of law and science reinforces the argument for developing a close alliance between the disciplines.

Certainly the *Gestalt* of law tends to conflict philosophically with the rigid "logico-inductive" processes of science, thus resulting in barriers to effective communications between the practitioners. To keep this communication problem in perspective, however, it is well to note that similar information impedances exist within the natural sciences. Common use of the scientific method has failed to bridge the communication barrier among scientific disciplines. It would seem that disparate logic is not the cause of breakdowns in communication — the cause is segregation of the disciplines. Institutions are traditionally organized on a disciplinary basis; physicists are housed in a department of physics; biologists are sequestered in a department of biology; lawyers are in a legal department. Each becomes highly proficient in intradepartmental communication; specialized languages develop, disciplinary logic becomes standardized, and a semifraternal atmosphere may persist. There may even be institutional policies which encourage the interaction among departments, but generally these efforts fail to result in meaningful cooperation because of insistence that disciplinary bonds be maintained. Occasionally individuals will overcome the inertia of the discipline-oriented system and develop professional relationships with colleagues from other departments. When spatial

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[31] *Id.* at 44.

[32] *Id.* at 15.

problems are overcome and the disciplines are brought to focus on a common problem, there is an interim period required for the group to adjust to jargon and philosophies. Only after the semantics are in order can truly effective communications result among the disciplines.

There has been little notable interaction between lawyers and scientists, or between natural scientists and behavioral scientists. Part of the problem has been the failure of scientists to recognize the relevance of law or sociology to what they consider to be scientific matters.[33] In most organizations the legal department's function is primarily administrative; it handles the commercial aspects of doing science-technology business, *e.g.*, contracting, patent work, and employee relations. It is not staffed for intellectual or academic pursuits. Most scientists never come in contact with lawyers in their normal course of business, and those that do often consider lawyers as technicians concerned with picayunish, esoteric details. We are dealing here with disciplines quite unaccustomed to talking with each other.

Given the basic differences in logic and methodology between law and science-technology, how can the universities better prepare scientists and lawyers to cope with problems of interdisciplinary communication? Formal education has a pervasive influence on the attitudes and philosophies one brings into his profession. In the past, universities have imbued students with acceptance of the separatist, disciplinary approach to problem solution. Recent trends in higher education indicate a recognition of the viability of the interdisciplinary approach leading to the establishment of interdisciplinary curricula. Today's students seem to realize that satisfactory solutions of the most important problems facing society can come only from the coordinated efforts of natural science, behavioral science, and law. The activism which permeates the campus has resulted in extracurricular student organizations being formed to attack social problems such as environmental pollution, racial discrimination, and consumer exploitation. These external activities fill a void which exists in the traditional educational structure. In some respects they are a monument to the failure of higher education to provide the "relevance" being sought by today's youth. An interesting feature of these extracurricular activities is that they achieve the necessary interdisciplinary approach to the social problem because they are unstructured to the extent that the resources are matched to the needs of the problem rather than the problem being narrowed in definition to fit the resources of a discipline. In other words, if the problem identified for attack is one involving, say, the pollution of an estuary, the unstructured student organization is free to seek voluntary contributions of knowledge from any willing disciplinary source available, be they in engineering, ecology, sociology, or

[33] Miller, *supra* note 26, at 597.

law. It is unlikely that the student group would ever consider restricting the definition of the problem to conform to the capabilities and resources of a single discipline. I cite these external student activities only as evidence that the new generation of science and law students recognizes the need for dialogue among the disciplines, and that through their extracurricular activities they are developing additional communication skills which will carry over into their professional careers. The educational institutions have responded to the student concern with new innovative cross-disciplinary courses and seminar series designed to improve communication and understanding. Another encouraging manifestation of the coming age of interdisciplinary concern is the large number of students crossing disciplines for graduate training. The results of this phenomenon may produce a "hybrid vigor," with the emergence of new substantive professional fields yet undefined.

Thus far I have dealt primarily with institutional deficiencies and personal rapport which tends to mitigate against effective interdisciplinary team research. The communication gap also extends to the literature. Science-technology has depended upon the written word to create the consensus required for acceptance of scientific theory. Science articles are generally written in the dispassionate, third-person language of the peer group. This mode of communication is persuasive and effective for those versed in the subject matter and familiar with the jargon. Lawyers write in the same manner for consumption by the bar. This is as it must be. But there is also a responsibility *sub silento* to inform those in other disciplines of the trends and concerns in one's subject area. This task has been largely assumed by journalists, with the result being that the information is filtered for content by one who is versed in neither discipline. I suspect that more law is read in magazines like *Time* or *Newsweek* by scientists, and more knowledge about science is gleaned from the same magazines by lawyers, than from any other source. To keep abreast of even a single narrow field of science, a person must seek his material from a score of specialty journals. In broad fields of interest like environmental affairs, one must consult an unmanageable number of periodicals from widely diverse disciplines to remain informed of the important developments. There are few interdisciplinary periodicals which summarize the research of a problem area; most are intended for publication of research resulting from the activities of members of the sponsoring discipline.

Legal periodicals are equally inaccessible to scientists-technologists. Law reviews, incidentally, serve an important function in assessment of science-technology. As the intellectual sounding boards of the legal profession, law review articles are often the first to identify and analyze the legal, moral, and societal dangers associated with a new technological or scientific development. The usefulness of the law review for legal analysis of problems associated with science-technology could be enhanced even more by a conscious effort on the part of the editorial staffs to identify sensitive areas of developing science so that perceptive, imaginative analyses of potential legal problems could be made in advance of the release of technology to the public. The copyright policy of most law reviews, however, limit their dissemination within the scientific community, and thus reduce their effectiveness as a feedback mechanism to the scientist.

Cross-publication by professional counterparts in both legal and scientific periodicals could improve information exchange by making the pertinent literature more easily available to the other discipline, and by compelling the contributor to translate disciplinary information into an understandable form.

Comprehensive key-word abstracting systems would also facilitate information exchange across disciplinary boundaries. The inclusion of scientific and legal titles within the same retrieval system would enhance the usefulness of the system to both disciplines. The use of key words, common to both legal and technical material, would insure retrieval of all pertinent information regardless of disciplinary origin.

Specialized curricula have been developed at many law schools to meet the need of specific problems confronting the legal process. These new areas of developing law are fascinating and capture the imagination of the creative student. But just as legal educators have come to realize the value of legal clinics in the training of practitioners, so must they consider the development of clinical programs and internships for those planning a career in dealing with the legal problems of science-technology. A summer spent in association with scientists and engineers at a large laboratory or within an institute or agency dealing with science problems could be most beneficial for both law students and scientists.

Continuing education should also incorporate interdisciplinary programs of instruction for the bar and scientist-technologist alike. Joint symposia should be developed to discuss specific mutual problems among scientists and lawyers. Cross-participation in professional meetings of both disciplines would serve as effective forums for confrontation between the disciplines. Scientists have also come to realize the importance of legal processes in achieving harmony between science-technology and society. Law will become more attractive for graduate study to the new generation of socially aware scientists. Educators may expect to see more students with backgrounds in science-technology enrolled in law schools in the future.