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SOCIETAL PROBLEMS AND THE IMPACT OF NEW TECHNOLOGY ON HIGHER EDUCATION

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Jarrod W. Wilcox

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MASSACHUSETTS
INSTITUTE OF TECHNOLOGY
50 MEMORIAL DRIVE
CAMBRIDGE, MASSACHUSETTS 02139

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Abstract

The probable impact of new technology on higher education from the point of view of the society is discussed. A number of new technologies are briefly described, a framework of basic societal problems and the functions of institutions of higher education in solving these problems is then outlined, and finally some of the likely major interactions between new technology and these functions are sketched.

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I. Introduction and Approach

One finds today a general consensus in the nation that the application of new technology to higher education over the next twenty years may potentially have dramatic effects. However, technological and sociological predictions are difficult not only because the causal factors are complex and not well understood but also because there are obstacles in gathering the basic intelligence data and perspective necessary to interpret the existing situation. These obstacles stem in large part from advice sources which are so closely identified in their interests with particular technologies, educational philosphies, or institutional roles that their expertise is subtly interlaced with partisan values and ideologies. Such expert opinions are treacherous because their proponents, like the rest of us, are themselves often unconscious of any partisan coloring or limited field of their views.

However, if one begins with an explicit recognition of the problems which higher education must address, one may avoid the initial bias toward particular solutions of the technologists. Further, if the analysis recognizes that problems do not exist in themselves but only with respect to the needs of particular individuals and social entities, much of the ideological miasma which has often infused these discussions may be dispelled.

Such an approach begins with the selection of a social entity whose problems will be addressed, followed by the selection of its relevant problems. This approach is not merely for convenience. Not only discussion of the impact of new technology but also many of the current controversies over the more general future of the university are marked by inattention to the inappropriateness of moral arguments which do not specify the beneficiary of the implied morality. This has been true not only of students who ask for a "fair" share of power, but also for faculty who protest "infringements on academic freedom," of university presidents who decry "irresponsible" students and faculty and even of the community and nation which fear a "decline in morality" and "treasonable dissent."

The recent issue of Daedalus entitled "The Embattled University" generally elevates this discussion; most of its participants recognize the intellectual futility of arguments toward changes in the form and governance of universities without explicit consideration of the functions of these universities. However, it is desirable, further, to associate these functions with the social entity they serve. In this essay, the focus is on the problems at the national or societal level.[1]

II. Areas of New Technology

The major technical innovations foreseen for use by institutions of higher education within the next twenty years are explained briefly in the following paragraphs.[2]

A. Programmed Instruction

The use of behavioralistic objectives and step-by-step reinforcement techniques as embodied in "teaching machines" and ordinary book-text programmed instruction is no longer a novelty. Despite the limitations of a "wired-in" approach, this use for well-structured material appears to be growing. Because good programmed instruction requires extensive capital investment in design, testing and revision, much of which has not yet been done even in subjects suitable to the technique, significant potential remains.

B. Computer-Assisted Instruction (CAI)

The incorporation of programmed instruction into a computer program allows much more branching and adaptability of the instruction to the variety of needs of different students than that attainable with normal hard-copy text. Economic use of the computer requires computer time-sharing, with many student-consoles attached to a single computer. Eventually consoles with video capability may allow a computer-controlled mix of traditional texts, programmed instruction, films, and computer-generated simulations. A number of experimental systems are in operation on an experimental basis; good examples are the work of Patrick Suppes at Stanford and Donald Bitzer at the University of Illinois. As various computer costs decrease perhaps another factor of ten, and as teacher's salaries continue to rise, these systems will become economic for many academically well-structured subjects. The evidence indicates they are already economic for certain highly specialized subjects such as teaching computer programming.

C. Computer Managed Instruction (CMI)

The programmed instruction and computer-assisted technologies focus on teaching highly self-contained packets of knowledge. In computer-managed instruction (CMI), on the other hand, the computer is used to guide the student in the sequence in which he applies himself to each discrete packet. Stored student test profiles are compared with computer-generated test results to provide a prescription directing him to the next packet, which may be a film, programmed instruction, or even a live teacher. Though such programs are still mostly in the research stage, they offer real promise for individualizing instruction.

D. Computer and Audio-Visual Techniques for Presentation

There are a wide range of technologies in which the special character of the technological device is used to transmit knowledge or present new concepts better than could a live teacher or professor. Prosaic examples are standard audio-visual equipment such as are now found in every school or college. New technologies in this area are computer or other simulations of phenomena which are complex or difficult to experience in real life. Good examples are simulations of macro-economic behavior, spacecraft response to pilot control, and the interactions of participants in international conflict.

E. Remote Broadcasting

The use of synchronous communication satellites to facilitate very large-scale, low-cost television broadcasts is approaching feasibility. Educational television networks and their stock of programs are continuing to grow. These facilities make possible the relatively inexpensive

distribution of lectures and films prepared by the nation's best talent to all areas of the country. The two most serious limitations appear to be the restrictions on learning from mere one-way communication and the lack of flexibility in having all schools and students tune in on the broadcast at the same time. The latter problem, however, is in the process of solution through the development of inexpensive video recorders such as the C.B.S. Electronic Video Recorder System. On a much smaller scale, the use of closed-circuit television within a university to bring the local talent to a large number of students is increasing.

F. Student-Initiated Access to Audio-Visual Recordings

At a few relatively new colleges, the traditional lecture has been partly replaced by a system of student-initiated access to audio recordings of the lectures. This system frees the student from the inflexibility of the classroom and its rigid schedule requirements. As costs continue to decline it will become economic to use video recordings, first in the classroom and then on an individual student basis. As libraries of video recordings are built, "outside reading" assigned in courses may become "outside viewing". Ultimately, such a technology may be combined with computer-managed instruction to provide effective individualized instruction. The technological components for such systems are already in existence; the development of economic systems of instruction utilizing them appears very likely within a decade or two.

G. Microfiche Libraries

The use of microfiche, highly miniaturized print on film, as a means both of library storage and as a primary media of publication is rapidly

growing. Even the present level of technology makes possible a manifold reduction in library space and a substantial reduction in "printing" and distribution costs. Developments are underway which may be expected to result in still greater miniaturization. This means that large libraries of printed material are going to become significantly less expensive than they are today. It may well mean that in twenty years every institution of higher education can have access to a first class instructional and research library.

H. Computer-Aided Search and Retrieval

The experimental use of computers in information retrieval is continuing to advance. Relatively simple systems based on keywords in document abstracts have been shown to support a surprisingly useful search and retrieval of requested information. More sophisticated systems incorporating some artificial intelligence "understanding" are in the applied research stage. Combined with the notion of microfiche cards and optical or magnetic-code computer "readers," they offer the possibility of computer-aided search or browsing. Further combined with timesharing and video computer displays, they offer the possibility of remote browsing. This raises the possibility of great national libraries serving wide areas. However, much further progress must be made in this area before such systems are economic.

I. Inexpensive Reproduction of Printed Materials

Xeroxed copies are now competitive in price with new textbooks. Despite the copyright laws, universities and colleges are finding xeroxed or multilithed materials a great advantage for use as outside reading material in

courses and also for research purposes. However, even more fundamental changes are on the way. Computer-driven high-speed "image formation" devices are beginning to have an impact on the publishing industry. New systems for computer output on microfilm provide fast, inexpensive, and compact distribution of printed material. These developments indicate a potential for inexpensive textbooks which are unique and individualized to the needs of a small group of readers, such as a single class, or even of a single student or faculty member.

J. Widespread Use of Computer Technology in General

As computation power has become widely available its influence has been felt throughout the society. Some institutions of higher education are now utilizing computer-based management information systems for clerical work and classroom scheduling. As more sophisticated uses are implemented in the management of industry, they will have an effect on the management of universities. In a different vein, the growing use of computers for research, in simulation models and in statistical analysis of research data, will probably continue, particularly in the area of the social sciences, where complexity is the rule.

K. Advances in the Technology of Instructional Improvement

Perhaps ultimately the most far-reaching new technology affecting institutions of higher education is one which is embodied in no particular device and is not extensively discussed. The cumulative effect of programmed, computer-assisted, and computer-managed instruction is not limited to better use of what is known now about instruction content and methods in

a particular academic field. A potentially more significant effect is a great increase in our ability to learn how to improve instruction of a particular subject over a period of time. The new ability to record and analyze student responses to particular packets of instruction, or even to a single sentence or adjective, may mean that a professor can develop highly effective courses of instruction based on two or three years of experience rather than on twenty.

III. Societal Functions of Institutions of Higher Education

If one takes the approximating view that in some sense the nation is a coherent self-sustaining societal entity, a kind of organism, it is clear that certain broad functions must be fulfilled, and that imperfections in these functions constitute basic societal problems.

Society must maintain itself against the continual degradations of increasing entropy as they are expressed through apathy, anomie, chaos, and social destruction. It must through economic production obtain and distribute the resources necessary for self-maintenance. If it is faced with dangerous competitors it must defend itself. Finally, society must adapt to changes in its environment and resources which interfere with the foregoing functions. Thus, the following categorization suggests itself:

a) preservation of culture, social stability, and cooperative participation of social sub-units;

b) economic production;

c) external security and cooperative relations with other societies;

d) economic, political, and cultural adaptation and innovation.

For example, as problems, the Vietnam War may be associated with both external security and social stability, student riots with social stability, inadequate housing with economic production, the space race with external security, and so on.

Taking this categorization as a starting point, what functions do institutions of higher education perform with respect to these problems? The current wisdom is the categorization of "intrinsic" university functions as research, teaching, and application, the last usually called "public service." However, the underlying reality may be usefully viewed as more complex.

Institutions of higher education have always been associated with knowledge, with varying emphasis on its preservation, distribution, production, and application, and with varying emphasis on its content--fact and theory, traditions, skills, social values and attitudes, and cultural aspirations. Such knowledge-related functions are not restricted to colleges and universities, which are what most of us typically mean by the phrase, "institution of higher education." Today, we might usefully characterize publishers, libraries, communications firms, the Federal Government, research laboratories, museums, consulting firms, and indeed many others as having a claim to be "knowledge institutions." In focusing on "institutions of higher education, one can more sharply focus analysis by generally restricting oneself to institutions concerned with knowledge in the public domain, rather than private knowledge, where that knowledge is more advanced than that readily assimilatable into the culture common to all of society's contributing participants.

In the following sections, interrelationships between societal markets for institutions of higher education, as thus broadly defined, and the consequent impact of new technology are traced in more detail. In light of the primitive nature of measurements of these areas, the discussion is limited to rough, qualitative prediction of the principal direction and importance of these consequences.

IV. Preservation of Culture, Social Stability, and Cooperative Participation

General education clearly has extremely important functions with respect to the societal problems of maintaining social stability and the cooperative participation of social sub-units.[4] The learning of social values and mores, mutual trust and cooperation, traditional culture, and the inculcation of sufficient practical knowledge so that the individual can assume some constructive role in society fall within this category; this constitutes the adaptation of individuals to an existing culture. For example, Acts of Congress in this country aiding education have often included a statement of purpose stressing the need in a democracy for a well-educated voting public. Higher education plays its part here in training individuals of special capacities for roles requiring more advanced knowledge (which includes, as it is used here, values, attitudes, etc.) than that readily assimilatable or desirable for the common culture. It also can be used to provide for merit-based social mobility, allowing some relief from too much class stratification and its consequent deletrious effects. In such an increasing technological and specialized society as ours, it becomes necessary for greater and greater proportions of the population to receive higher-level vocational education, and some of this may be considered "socialization."

By generally calling into question established traditions and values too rapidly through the production of new knowledge, higher education can threaten the fabric of society rather than strengthen it. On the other hand, institutions of higher education often act as preservers of socially binding values and traditions. They also can attack, through research, faculty consulting, or application task forces specific problems disturbing social stability and constructive participation. For example, we see today increasing efforts by the universities in urban affairs, in bringing minority sub-cultures into the mainstream of society, and in developing management expertise for broad social problems. Because of growing social unrest, and particularly as a result of the current student strikes and rebellions against the war in Southeast Asia and the establishment system, one can reasonably predict that the national demand for social stability and constructive participation will sharply increase in the near future.

Any of the technical innovations briefly described in Section II might have indirect impact on satisfying this market; several will probably have considerable direct impact. Clearly, also, the general advance of new technology creates disturbances and thus a demand for this market.

There is a fairly general consensus that computer-assisted and computer-managed instruction will, by reducing the resource complementarities in teaching large masses of students, greatly increase the opportunities for more individualized instruction. Student-initiated access to audio-visual tapes and ordinary book-text programmed instruction also will have a strong impact in this direction.

What is not so clear, however, is the extent of societal, as opposed to student, demand for individualized instruction. Individualized instruction directed toward the effective socialization of the societal drop-out could result in more students attaining a high level of cooperative participation in society, and conceivably toward more effective utilization of society's resources in bringing students through the educational process. However, individualized instruction may be a two-edged sword if its use represents a substitution for the kind of group socialization experience which is now employed in educational institutions in teaching social values and attitudes. That is, the desirable motivating and efficiency aspects of individualized instruction must be weighed against the possible losses in foregoing group and teacher-student socializing experiences.

A second major innovation bearing on this market is the use of low cost mass-media in helping students in less advantaged regions and social strata attain education more similar to that provided for the majority. The tendency toward reduction of educational differences between white and black sub-cultures, among the suburbs, the rural hinterlands, and the urban ghettos, between North and South, must lead in time to the formation of a more socially unified common culture. This kind of effect operates in the direction in <u>increasing</u> the resource complementarities in mass teaching. One can expect a growing use of instructional material nationally distributed through orbital satellite or other live communication networks or, if they become sufficiently inexpensive, through video tapes. The same might apply to computer-assisted instruction programs. Though such

trends have mainly been hoped for because of their beneficial intellectual learning effects, one can well imagine that the spread of more homogeneous social attitudes will have an equally significant effect.

A third potentially important but so far unheralded impact on this area may be a great increase in the effective preservation of cultural knowledge, values, traditions, etc. through the increased availability of film and video-tape. As colleges, libraries, and museums become more able to provide audio-visual offerings, a more effective transmission of cultural heritage will become possible, particularly through the preservation of news films and of performances of the arts.

V. Economic Production

The second major societal problem, economic production, represents a distinguishably different market, though this demand category is hazy.[5] One is led to incorporate here apart from the first category that part of instruction which represents "neutral" technical knowledge, a kind of distinction which might be useful between parts of "liberal arts" and "vocational" education.

Institutions of higher education also perform a very significant function connected with economic production in evaluating, sorting, and labeling students for greater efficiency of their utilization by other social institutions. Whatever the merits of grades and other evaluative labels from the point of view of learning, they serve an important, though imperfect, function in the selection of students for societal roles. This function is currently under attack, but continues to thrive.

The slow but continued progress of testing methodology, combined with the wide-spread use of mass computer-scored testing, has already made possible considerable efficiencies in sorting students through colleges and universities and thus into particular vocational and professional educational programs and, ultimately, into particular societal roles. The increased individualized testing which will be made feasible by computer-assisted and computer-managed instruction may very well abet this role by institutions of higher education. This would be ironic since some of the most avid supporters of individualized instruction appear strong critics of the use of grades. It is conceivable that the present student revolt against the use of grades represents a futile transient reaction to a strongly increasing trend. As computer technology makes possible the accumulation of greater information about the student's capabilities, the student may find himself more, rather than less, channelized by the university's evaluation of his abilities. Conversely, the university may be forced to develop new, more explicit criteria.

A second major impact, which has been widely discussed in the literature, is the effect of individualized instruction on the possibilities for continuing adult education. By reducing the complementarities between student's educational programs, new technology such as computer-assisted instruction and student initiated video-tape service will allow adults to continue their education at their own pace and to a greater degree of specialization than that possible if they were bound to the classroom. They will also be more free to structure their education into the time and location constraints set by their ongoing societal roles. Thus, the concept of life-long educa-

tion is directly tied to the technical possibilities for individualized instruction. This life-long education may well contribute to noticeably greater economic productivity in the individual's later years.

In addition, all the instructional and library technological aids which make possible a given level of effectiveness at reduced financial costs will have an impact on the societal market for economic production by releasing societal resources. Indeed, this is probably the most important influence underlying present governmental interest in educational technology, particularly at the state level. Of course, there is no particular reason to suppose that such savings will not be compensated by increases in other costs, particularly in wages and salaries, so that it would be foolhardy to predict an actual decrease in total educational expenditures.

VI. External Security

The third major societal market, external security and cooperative relations with other societies, experiences very wide fluctuations in its demand for services from institutions of higher education. This market potentially includes the requirements of the military, international diplomacy, and to a degree, the exploration of external territory such as the ocean floors and outer space. When high levels of internal ideological cohesion and economic strength are perceived as weapons in international struggle, this market may even influence indirectly demands more typically thought of as social stability or economic needs. It would be naive to expect knowledge in the public domain which is not yet readily assimilatable into the common culture and which is useful for external security

not to be cultivated by the society. The question as to whether this will occur in the same institutions also responsible for instruction and research for internal purposes is open, and must depend in society's view upon the degree of complementarity among these activities when carried out under the same institutional roof.

Fluctuations in this sort of demand were clearly noticeable in shifts in the activities of universities during World War II and in the nation's entire educational complex during the more recent Sputnik era.[6] The existence of these markets has had a far-reaching affect on the nation's major universities; consider, for example, the National Defense Education Act.

On a different front, military requirements for the output of institutions of higher education not untypically are associated with innovations in the use of new technology in instruction. There are certain markets, such as pilot training, for example, which justify very high expenditures per student instruction hour. The use of computer controlled equipment simulators is a good example of a response to this situation. Thus, parenthetically, the military market may be instrumental in the development of new educational technology with wider uses. The armed forces constitute a large market for instructional services since much of their transient personnel must be educated to a high level of skill and knowledge in a short time. Technology such as video tape computer-assisted instruction which gives some promise of inexpensive or more rapid education will have a noticeable impact on the armed forces' ability to reach a higher level of professional specialization using transient personnel.

The potential advantages in library effectiveness through microfiche libraries, computer-aided library search and retrieval, and the use of the computer generally are bound to have eventual significant results regarding the ability of those associated with foreign or military intelligence activities to develop and maintain useful knowledge. Whether this will affect universities is an open question.

Clearly, another large market in this sector is for research and application of advanced knowledge to problems of defense, international development and trade, and so on, but the special impact of new technology here is not clear. One might reasonably conjecture, however, that the ability of the computer to aid in the analysis of very complex systems might lead to increased involvement by institutions of higher education in research and consulting for external security in the behavioral sciences and management, but again, this is quite conjectural.

VII. Social Innovation

The fourth major market for the services of institutions of higher education is that for innovation and improvement, whether in the socio-political, the economic, or the external relations sphere. As Clark Kerr remarked in The Uses of the University, this is a market that has grown significantly as the nation has learned the value of research knowledge in solving its problems. Some within today's research-oriented major universities may even regard the production and distribution of innovation-stimulating knowledge as the major function of their institutions. Yet institutionalized and effective public research, as distinguished from

certain forms of scholarship whose societal results are limited primarily to knowledge preservation and self-instruction, appears to be a phenomenon relatively recent on a historical scale, and it still does not bulk very large in the proportion of the society's resources which are devoted to it.

Specifically, the extent of this demand should not be over-estimated; innovation nearly always requires painful and disruptive diversion of resources from attention to current political, economic, and security problems. Thus, the demand on institutions of higher education for research and social innovation is subject to many constraints and negative reactions, as researchers currently dependent on government grants can testify.

The demand for innovation is a demand for instruction in innovational concepts and techniques, a demand for research, and a demand for institutions of higher education to actively participate in application of knowledge to stimulate practical innovation. New technology may be expected to have many indirect and difficult-to-predict effects on this market.

With respect to research, one may repeat the conjecture that the new aids to library usage and the widespread use of computers in research will tend to make research in areas where much is already known more efficient and to increase the pace of research progress, particularly in the social sciences. It is not clear, however, to what extent this research progress will actually be reflected in a faster pace of innovation; the latter is limited by other factors.

VIII. Summary

In this essay, the societal demands for the services of institutions of higher education and the impacts of new technology on the institutions' capability to service this market have been sketched. By bringing together variant problems and points of view into a single societal vantage, a broad perspective has been cultivated.

However, the implications of new technology for changes in the internal structure of institutions of higher education and for shifts in the relative demand for different types of such institutions have not been explicated; nor has the impact on faculty or on students. An analysis based on these other social entities would take different perspectives. However, since the margins for incompatibility of their interests with those of the general society are limited by societal problem pressures, our approach may serve as a useful starting point for interpreting the impact of new technology on higher education. At the least, it may serve to question those who speak solely from technological interests or from identification with the special needs of students, or of faculty, or indeed of colleges and universities as we know them today.

FOOTNOTES

[1]For some interesting commentary regarding the differences among the relevant problems of students, faculty, and society as a whole, see Christopher Jencks and David Reisman, The Academic Revolution (Garden City, New York: Doubleday & Co., 1968).

[2]Some rather differently oriented comments from those which follow on the probable impact of this new technology, not limited to higher education, can be found in the following:

Alvin C. Eurich, Reforming American Education (New York: Harper and Row, 1969);

Werner Z. Hirsch (ed.), Inventing Education for the Future (San Francisco: Chandler Publishing Company, 1967);

U.S. House of Representatives, Committee on Education and Labor, "To Improve Learning," report by the Commission on Instructional Technology (Washington: Government Printing Office, 1970);

Alvin C. Eurich (ed.), Campus 1980, The Shape of the Future in American Higher Education (New York: Delacorte Press, 1968):

[3]The classic statement of the past decade on this topic is, Clark Kerr, The Uses of the University (Cambridge, Mass.: Harvard University Press, 1964).

[4]See James S. Coleman (ed.), Education and Political Development (Princeton, N.J.: Princeton University Press, 1965), pp. 3-32.

[5]See E. A. G. Robinson and J. E. Vaizey (eds.), The Economics of Education (New York: St. Martin's Press, 1966).

[6]See, for example, James Phinney Baxter, 3d, Scientists Against Time (Cambridge, Mass.: MIT Press, 1946).