DOCUMENT RESUME

ED 313 968 HE 023 073

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TITLE An Organizational Conception of Curriculum and an Application to Professional Education. ASHE Annual Meeting Paper.
PUB DATE Nov 89
NOTE 58p.; Paper presented at the Annual Meeting of the Association for the Study of Higher Education (Atlanta, GA, November 2-5, 1989).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Allied Health Occupations Education; *College Curriculum; *College Environment; Curriculum Development; Educational Environment; *Educational Planning; *Educational Quality; Higher Education; Organizational Climate
IDENTIFIERS *ASHE Annual Meeting

ABSTRACT

Curriculum may be more adequately explained as the work of an organization than as a plan for individual learning. Research is reported based upon case studies of four allied health programs in one university with the intent to employ concepts from the organizational literature to describe a group of curriculums, and to determine if relationships among variables exist and yield a coherent explanation. The four programs were medical technology, nuclear medical technology, physical therapy, and physician assistant. The programs are distinct in having varying relationships to the dominant health care profession of medicine. Descriptions of each program were combined into one descriptive case study with the goal to promote internal validation by utilizing multiple sources of data and the perceptions of multiple investigators, and then rely heavily on internal consistency as the criterion of validity wherever possible. Results are discussed according to: environments of academic programs; boundary setting and boundary spanning; curriculum as an organizational technology; and outline of a tentative model. Curriculum can be most adequately explained by considering it an organizational phenomenon. Higher education curriculum might benefit from an emphasis on more complex organizational technology and structure issues. Contains 44 references. (SM)

AN ORGANIZATIONAL CONCEPTION OF CURRICULUM AND AN APPLICATION TO PROFESSIONAL EDUCATION

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This paper was presented at the annual meeting of the Association for the Study of Higher Education held at the Ritz-Carlton, Buckhead in Atlanta, Georgia, November 2-5, 1989. This paper was reviewed by ASHE and was judged to be of high quality and of interest to others concerned with the research of higher education. It has therefore been selected to be included in the ERIC collection of ASHE conference papers.

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Introduction

We propose that curriculum may be more adequately explained as the work of an organization than as a plan for individual learning. Characteristics of curriculums are as related to the complexities of environmental conditions and of organizing work within educational institutions as they are to considerations involving individual learning. Learning should play a role in curriculum theory, but to be effective, prescriptions for improvement (of learning) must be embedded in an adequate explanation of the (organizational) context within which they are to be effected.

The research reported here is based upon case studies of four allied health programs in a single university. Our intention was to employ concepts from the organizational literature to describe a group of curriculums, and to determine if relationships among variables exist and yield a coherent explanation. We do not regard the research as a definitive test of an organizational model, but rather an exploration of its potential.

Why an Organizational Conception?

An organizational conception of curriculum addresses a fundamental discrepancy in the field. The literature in recent years has begun to recognize that curriculums are heavily influenced by external factors and that curriculum development occurs within an organizational context (Conrad & Pratt, 1983; Stark

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Presented at the annual meeting of the Association for the Study of Higher Education, Atlanta, GA, November 3, 1989.

et al., 1986; Stark & Lowther, 1986). The curriculum itself, however, continues to be described and analyzed primarily as a learning plan for individual students.

The discrepancy between conceptions of curriculum and the organizational reality of their existence may be stated more explicitly in terms of four problems associated with the lack of fit. These include the appropriate level of analysis for research, the inconsistencies between organizational explanations and individual learning explanations of kindred phenomena, the inadequate and generally implicit organizational assumptions brought into existing curriculum models, and, to distribute the problem more evenly, the lack of attention by organizational research in higher education to the work of the organization as a significant element in organizational studies. Each of these is a complex issue and the problems are summarized only briefly here.

From the perspective of improving research in curriculum, the problem of an organizational versus an individual learning approach is substantially one of the appropriate level of analysis and of the need for linking concepts when attempting to explain phenomena across levels. Baird (1988) has analyzed this problem with respect to research on college environments. In that research, structural concepts, such as peer group formation and influence, link environmental and individual variables. The results are considerably advanced over comparable research on the formal curriculum. The problem is even more acute when the objective is to explain variations in curriculum itself. Curriculum is a structural level phenomenon which the literature, summarized briefly by Conrad and Pratt (1983), addresses as a political process issue of power and influence, ignoring other organizational variables even as potential mediators of influence.

Organizational research also offers potentially competing explanations of curriculum that have been largely ignored by the curriculum literature. One topic developed in this report is interdependence among instructional elements

such as courses and academic units. Curriculum theory with its emphasis on sequencing and integration promotes linkages and hence greater interdependence among these elements of instruction as a means of enhancing learning. The organizational literature in contrast (Thompson, 1967; Williamson, 1985), concludes that interdependence should be held to the minimum needed to accomplish a task because of the cost of managing that interdependence.

Although curriculum theorists have largely ignored the organizational context until recently, organizational assumptions have inevitably found their way into curriculum models. We would describe the prevailing assumptions as rational, single-task, cost-free and deterministic. Prescriptive curriculum theories typically begin the process of design with a statement of goals which serve as the fundamental guidelines for planning. The organizational literature is far more cautious about goals, beyond their obvious role in promoting favorable relationships with the environment. Curriculum theorists assure instruction to be the single task of the organization. Economists such as Garvin (1980), note that universities have multiple production functions of research and service as well as instruction and that these are typically related; i.e., the instructional function is carried out in ways that are consistent with the joint product of research. Similarly, though the role of resources is acknowledged in curriculum, particularly by Dressel (1980), effectiveness rather than the efficient use of scarce resources is the central criterion in curriculum development. Finally, uncertainty plays no role in formulations of curriculum, whereas it is central to several conceptions of organizational behavior (Cyert & March, 1963; Williamson, 1985).

A final problem addressed by an organizational conception of curriculum is that organizational research in higher education has avoided the systematic study of curriculum an as organizational technology. Organizational scholars such as Bess (1982), Clark (1983), and Cohen & March (1974) offer significant insights regarding curriculum, but not as the result of systematic study of the

technology of institutions. Peterson's (1985) summary of the organizational literature in higher education reveals no major work centered around technology. An organizational conception of curriculum has the potential to contribute to the organizational literature in higher education as well as to curriculum.

The Initial Framework

The initial frame of reference for an organizational conception of curriculum has been Scott's (1987, based in turn upon Leavitt's, 1965) five basic characteristics of organization: environment, technology, structure, goals, and participants. This framework is fundamentally consistent with Clark's (1983) explanation of academic work, though Clark does not explain curriculum in any detail. Scott's synthesis of organizational research establishes that all organizations are interdependent with their environments for resources and for absorption of the goods and services produced. Technology is the work of the organization, and includes the resources employed as well as the processes utilized (Scott, 1987, p. 212). Curriculum and the related processes of instruction constitute a technology by which educational institutions accomplish the work of instruction.

Since knowledge is the primary material of academic work (Clark, 1983), the conception of social frameworks of knowledge (Gurvitch, 1971; Holzner & Marx, 1979; Holzner, 1983) was added to the Scott's framework to address several of the distinctive characteristics of academic work. Each organization of knowledge, such as a curriculum, can be described in social structural as well as cognitive-epistomological terms. The social structure of curriculum can thus be defined in terms of the distribution of knowledge related and other educational activities, roles, and forms of differentiation and integration within and across the social structure of organizations.

Work in an organization involves the differentiation of activities, coupled with integration of those activities which are interdependent. Interdependence must be managed or coordinated if organizational tasks are to be accomplished.

Thus, the social structure of technology coordination becomes a significant element in organizational structure.

The organizational literature places heavy emphasis on the relationship between technology and environment, and between technology and structure (Scott, 1987); these have been the foci of our efforts. Formal goals have not been found to be substantially related to curriculum. The study of participants and their relationships is predicted to be more relevant and is a substantial next step. We have concentrated on the more cognitive aspects of curriculum and have not developed the broader aspects of socialization that are related to relationships among participants as well as to social structure (Bucher & Stelling, 1978).

Methodology

The research was concluded in several stages, beginning with a conceptual phase, and preceeding through the development of an appropriate methodology, sampling and data collection, analysis and synthesis of results, and formulation of a tentative organizational model of curriculum. The conceptual phase initially sought to place more individual conceptions of curriculum within a relevant organizational framework, and then to translate the former into the latter. The conceptual literature in curriculum has been summarized in recent years by Conrad and Pratt (1983), Dressel (1980), and most recently by Stark and Lowther (1986). The organizational literature explored was both conceptual and empirical (Clark, 1983; Miles & Snow, 1978; Thompson, 1967; Williamson, 1985; Woodward, 1965). The empirical research, especially the studies summarized by Woodward (1965), provided a number of specific insights into potential linkages between organizational conceptions and curriculum. The conceptual phase also drew upon the results of an earlier study (Hughes, 1987; Hughes & Sagen, 1987) from which the current research has evolved.

Within the initial framework established, we then attempted to translate specific individual level curricular concepts such as sequencing and integration

into structural level terms such as interdependence, and to expand the more narrow individual level model to a view of curriculum as the work (technology) of an educational organization.

The empirical research on technology suggested two methodological emphases, exploratory case studies, and a longitudinal approach. The current organizational conception of technology (Scott, 1987) represents the synthesis and the resynthesis of a series of case studies, primarily in manufacturing (Miles & Snow, 1978; Williamson, 1985; Woodward, 1965). Further exploratory studies of this kind are warranted where the general framework is extended to other sectors such as higher education. A longitudinal approach, retrospective in this research, is especially appropriate to considerations of technology and structure where problems of lag and discontinuities in relationship have long been acknowledged (Chandler, 1962; Piore, 1979).

Case study methods in education have been utilized primarily for exploratory purposes, rather than to test theories (Merriam, 1988). Our approach of typological analysis (Goetz & LeCompte, 1984) falls midway on a continuum (Crowson, 1987; Goetz & LeCompte, 1984) between the naturalistic inquiry promoted by Lincoln and Guba (1985) and the theory testing use of case studies described by Merriam (1988). Typological analysis applies prior theoretical categories to new data, but provides for elaboration and refinement of concepts as the research proceeds.

Retrospective case studies were conducted of four allied health programs located in a midwestern comprehensive research university academic health care center. The four programs selected for study were medical technology (MT), nuclear medical technology (NMT), physical therapy (PT), and physician assistant (PA). Allied health programs in general and the four programs specifically exhibit several characteristics that make them reasonable candidates for curriculum study. The programs are of relatively recent origin, the oldest one (PT) established in 1942, the newest (PA) in 1972. Interview data as well as written

records may thus be used to examine the history of each program. MT, NMT, and PT originated outside the university academic structure. The influence of academic structure as programs are brought within that structure can be examined. The programs are relatively small, ranging from NMT with typically about six new enrollments per year to PT with 30 per year. The time spent in specialization is two years, except for NMT which is a one year program. PT is a post-baccalaureate program resulting in a master's degree. The others are baccalaureate degree programs, although PA can be pursued as a combined baccalaureate degree and MS degree in preventive medicine. All are decidedly professional programs, although two (MT and NMT) were organized for some substantial time as BS degree programs within the university's College of Liberal Arts.

The two distinctive features of the programs with respect to curriculum are perhaps their varying relationships to the dominant health care profession of medicine, and the fact that health care alone among professional programs often embodies its clinical training site (primarily a university hospital) within the formal organization of the university (Halpern, 1987). (Three of the programs, MT, PT, and PA, utilize clinical sites outside the university as well.) The interaction of the technology and structure of the university with the technology and structure of the clinical site can thus be approached in more systematic fashion than is possible with other professional programs.

The methodology was based upon several basic principles of qualitative investigation summarized by Crowson (1987) and by Lincoln and Guba (1985). Multiple sources of data and multiple observations were utilized wherever possible. The case studies began with existing records, following the strategy of direct research advocated by Mintzberg (1979). Both the University and the College Medicine maintain archival records and these along with the records and resources maintained by the several programs provided catalogue and other program descriptions, self study reports for accreditation, records of program initiation and modification, and course syllabi. Health professions programs

especially are required by government funding regulations to maintain systematic program and enrollment data.

The analysis of written records was then complemented and compared with multiple interviews with approximately 15 program faculty and other faculty and administrators. Because of the recent history of each program, several of the interviews were able to review the history of the four programs since their introduction into the university, as well as their current status. The methodology also involved a considerable degree of participant observation. Two of the researchers are faculty in one of the programs (MT) and the field work was carried out primarily by these two researchers.

The initial descriptions of each program were developed independently and these results were analyzed by the third researcher and discrepancies and problems noted. The descriptions of each program were then combined into a single descriptive case study. The goal was to promote internal validation by utilizing multiple sources of data and the perceptions of multiple investigators, and then rely heavily on internal consistency (triangulation) as the criterion of validity wherever possible.

Results

Environments of Academic Programs

Types and dimensions of environments. Comprehensive universities verify the proposition that environmental complexity leads to comparable differentiation within the institution. Professional programs represent the extreme of this differentiation. The College of Medicine responds to a different environment than the College of Law, and the Physical Therapy Program to an environment differing substantially from that of the Physician Assistant program. Further, the relationships among units in a university are often more like those between a federation of organizations (Merton, 1957) than between units in a single organization. We thus found it useful to define environments as both

external and internal.

Our exploratory research identified at least four major types of environments (output, regulatory, resource, input) affecting curriculum (Figure 1). The domain of practice includes the technology of practice from which the tasks of education are derived. The social structure of practice refers to the social arrangements such as private practice versus hospital employment within which practice occurs. This environment is external for professional programs, though it could well be internal for areas such as general education where advanced specialized programs absorb the products of general education. The remaining environments are both external and internal to the institution.

Insert Figure 1 About Here

Two other sets of environmental characteristics, central to organizational studies (Scott, 1987), are fundamental to our understanding as well. Organizational environments can first be described according to the extent they are institutionally elaborated or technical-market (Meyer, Scott, & Deal, 1981). Organizations in the public sector especially are described as elaborations of social norms and values. The elaboration of education as a social institution leads to the creation of organizations which embody the norms and beliefs associated with the institution and to maintenance of the organization by conforming to those norms. Business organizations, in contrast, though created by the elaboration of markets as social institutions, are related to those markets by exchange relationships involving specific goods and services. Technical-market organizations are maintained by their efficiency in producing goods and services exchanged with the environment, typically in competition with other organizations.

Figure 1

Environments of Professional Programs

Output Environment (Domain of Practice)

- Technical
- Social Structure
- Supply and Demand

Regulatory Environment

- Accreditation
- Licensure-Certification
- General-Legal
- Institutional (Internal)

Resource Environment

- Knowledge
- Human Resources (Faculty and Staff)
- Clinical Sites
- Other Instructional Resources

Input Environment (Enrollment)

- Structure
- Supply and Demand

The second set of environmental characteristics concerns interdependence and uncertainty. Interdependence between organizations and their environments as sources of inputs and receptors for outputs has been mentioned earlier. Uncertainty over resources and the acceptance of outputs can be a major factor affecting structure and technology.

The current exploratory research examined environments at the fundamental level of those elements playing complementary roles; e.g., suppliers of needed resources and competitors for those resources. Health care and educational environments are of course more complex and interdependent than this, often involving secondary relationships.

Output environments. The four professional programs represent an elaboration of the social institution of health care and its norms such as an emphasis on acute versus chronic and preventive health care, considerable freedom of consumer choice and thus the creation of markets to some degree, and the subsidy of health care in most cases by third party payments. The considerable control exerted by the medical profession over all areas of health care also represents a basic social norm elaborated through government and other regulations. Within these contours, however, the major sources of curriculum change can be largely ascribed to 1) advancements in basic scientific knowledge, in turn extending the knowledge base of practice, 2) technological advancements in practice such as the use of computers, and 3) market forces which are forcing substantial cost containment practices upon the health care system.

The nature of practice in the four programs varies substantially. Three of the professions (MT, NMT, and PA) represent the assignment of selected more routine elements of medical practice to persons who would be described initially as paraprofessionals. Recent development in these fields, however, have begun to separate these occupations from medical practice along the lines of "centrifical specialization" (Moore, 1970) in which new professions are spun off and eventually can be no longer controlled by established professions. The complex-

ities of instrumentation in MT and the movement of PA into areas of preventive health, which are more in the public health sphere, have begun to remove these fields from the direct control of the medical profession.

The four professions each reflect the routinization of the diagnostic dimension of medical practice, and for PT and PA, and NMT to a lesser degree, the therapeutic dimension as well. This routinization originated in the molecular revolution which brought together the disciplines of chemistry and biology and whose systematic differentiation into sub-specialties such as immunology forms the basis for much of modern medicine.

In the case of MT these advances in basic science were coupled with the development of sophisticated electronic instrumentation linked in turn to computer analysis. NMT represents the systematic use of controlled radiation for both diagnostic and therapeutic purposes. The complexity of analyses and of instrumentation in MT have resulted in internal differentiation in the profession and the curriculum into subtracks. (Differentiation has not taken place in the formal certification for practice.) PA has similarly developed specialized practice in specialty areas such as internal medicine and surgery. PT and NMT have remained single track professions.

The involvement of PT, PA, and to a lesser extent NMT in therapy requires direct contact with patients and a behavioral technology of practice associated with client relations and behavioral interventions. (The basic behavioral sciences play only a slight role in profession preparation, however.)

The technology of practice is substantially related to the social structure of practice and cannot be easily separated. MT and NMT graduates are employed almost entirely by hospitals. Hospitals are well organized, and in conjunction with the medical profession exert a considerable measure of control over MT and NMT through regulatory and other mechanisms.

The social structure of practice for the other two professions, PT and PA, has shifted substantially in recent years. PT represents a situation somewhat

different from the other professions since the therapeutic and especially the training dimension of practice extend beyond the control of medicine. PTs have thus established themselves in private practice and non-hospital organizations to a far greater degree than the other allied health professions. PAs have likewise entered public health and other areas not controlled by medicine and have shifted from primarily office assistant roles to practice in most of the major medical specialties.

These changes along with the increased autonomy for MT and NMT were influenced by the desire of third party payers to shift health care away from medicine to less costly professions. One consequence for PT and PA has been to open for these professions new areas of practice and new markets which are not controlled by the medical profession or by the employing organization. The impact on earnings for PT and PA has been substantial, in contrast to MT and NMT which have remained largely under the control of employing hospitals.

The concentration versus dispersion of employers as well as their level of organization proved a significant factor in the external environment. For reasons we cannot easily summarize, over half of the graduates of MT are employed initially at the university hospital. Placement in the other professions is more varied and in the case of NMT and PT is essentially national. Concentration of MT employment at the local university hospital gives that organization considerable influence over the MT curriculum.

Differences in the social structure of practice are reflected in the monetary rewards and opportunities for advancement in the several professions and, not surprisingly, in the supply and demand levels in these fields. MT and NMT place graduates in the range of $22,000-25,000. Entry salaries for PT and PA are perhaps $7,000 higher. Chances for increased earnings and advancement are slight in MT and NMT while experienced PAs average about $40,000-50,000 and incomes of $80,000 are not uncommon among PTs in private practice. Differences in income potential have a substantial impact on the enrollment market.

Demand for professional practitioners exceeds supply in all four professions. The market for MT has been the most volatile. Hospital employers attempted to cut costs in the early 1980s by turning to technician level personnel and to contracts with outside laboratories for services. These strategies largely failed, but the resulting decrease in MT enrollments has created an even greater demand for practitioners.

Regulatory environments. The external regulatory environment for academic programs was found to have little substantial effect on curriculums. Accreditation of programs and certification of practitioners through examinations represent institutionally elaborated norms that generally lag changes in allied health care practice. The programs responded to the changes associated with advancements in molecular biology and computerization well before these were reflected in accreditation standards. Certification examinations indeed may contain items that are no longer part of modern practice.

Accreditation and licensure-certification are heavily affected by their organizational set (Blau & Scott, 1962). This set of actors, defined by their complimentary roles, includes institutions and programs, along with each profession and the more controlling medical profession in all but PT. Participants in the organizational set often compete, yet must cooperate to define the field. Short of direct intervention by government, professional accrediting agencies and the professions are unlikely to impose new standards until a critical mass of programs is ready to meet those standards. This is illustrated in the case of PT changing its accreditation standards to require a master's degree program. The move was promoted by PT programs and by the time the standards were revised, the PT program required virtually no changes to conform to the requirements for a master's degree. Limiting the case studies to a single institution undoubtedly limited the impact of the regulatory environment. Examination of a wider range of institutions would have likely discovered marginal programs affected by accreditation and certification requirements.

The general-legal environment for academic programs has not been explored in any detail. Threats of malpractice and government regulation have clarified and somewhat changed the status of students in MT where students can no longer be used in actual hospital work.

The role of the baccalaureate and master's degree structures and other institutional requirements within which the four professional programs are organized proved difficult to define. We conclude that these structures and requirements represent the internal elaboration of the broader social institution of education, defined initially through accreditation and other mechanisms. Baccalaureate degree recipients are expected to possess a general education, and master's degree recipients are expected to be competent in research. Programs conform to these norms in the sense of requiring a distribution of courses to meet general education requirements, and course work and products labeled research at the master's degree level. In the case of general education especially, these requirements were simply added to professional requirements with no meaningful linkages sought or expected. The reverse hypothesis is that given the reality and complexity of professional programs at the university, baccalaureate and master's degree requirements in general must be kept loose so as not to constrain the more specific requirements of specialized preparation.

Resource environments. Resources for academic programs exist in the external environment and within the institution. Knowledge is of course the major resource of educational programs. Knowledge is typically first published in the field and then brought into the curriculum. Even local "practice" knowledge is typically created outside the curriculum and is brought in by practitioners and others.

Within the institution, programs confront the dilemma of incorporating knowledge directly into the program or relying on other units to teach that knowledge. In some cases knowledge outside the program may be organized for purposes not entirely compatible with those of the program. In other instances

a program may encounter the monopoly of another unit in a particular area of knowledge.

Similar problems of access exist for other instructional resources such as clinical settings. University academic health care centers may acquire highly expensive physical and human resources which are used primarily for health care, though secured ostensibly for purposes of health professions education. Presumed principles of learning are often abandoned, and elements of practice learned ahead of basic theory for example, because limited access to clinical facilities requires that some students be scheduled for clinical rotation before they are instructed in relevant theory.

Input environments. Input or enrollment environments are essentially market driven and are the most uncertain for several programs. The environment may be both external and internal. MT and NMT draw most of their students from the general undergraduate enrollment of the university. PA, and PT especially as a post-baccalaureate program, draw more heavily from the outside, although the majority of the enrollment in both cases originates at the university. As part of a state system of public four year institutions, and through cooperative relationships with community colleges, the three undergraduate programs are required to admit qualified transfers to the pool of applicants from which enrollments are selected.

The enrollment market is substantially affected by the employment market. Two of the programs (PT and PA) have a favorable environment and have increased their selectivity in recent years. Both of these programs offer career opportunities far substantial to those offered by MT and NMT. NMT is an extremely small program (about six enrollees per year) and has maintained its quality without a substantial pool of applicants. MT has been the most adversely affected by the enrollment environment, with both the pool of applicants and the quality of enrolled students declining somewhat in recent years. MT, as a female dominated scientific occupation, now finds itself in direct competition

with professional programs such as medicine and law for high ability females. The ratio of females to males in MT has shifted from 6:1 to 2:1 in recent years.

Boundary Setting and Boundary Spanning

The establishment and modification of organizational boundaries has received little attention in higher education, in contrast to business where its relationship to anti-trust litigation and legislation is obvious (Williamson, 1985). The boundaries of public educational organizations and of specific programs are established often through legislation and other regulations, and modification of the basic boundaries is difficult. The major program boundary setting decisions occurred on the input side where program boundaries were established within the internal university environment at the point of student admission. Among the baccalaureate programs examined, PA will formally admit students at the end of the sophomore year. MT in the middle of the junior year, and NMT at the end of the junior year. Post-baccalaureate programs such as PT, and some baccalaureate programs such as engineering, admit students directly.

The internal environment of an university is much like the external environment, with academic programs competing for students who will enroll initially as general inputs (freshmen) to the university. Programs may be forced to extend their boundaries; i.e., admit students earlier to maintain enrollment in much the same way a manufacturing corporation might purchase one of its suppliers of necessary parts. MT is the most enrollment vulnerable of the programs and has extended its boundary by a semester to secure enrollments. Pa, which along with PT has the most favorable enrollment situation, will formally admit students after their sophomore year. The majority of PA enrollees, however, already possess a baccalaureate degree. So, in fact the PA input boundary is set operationally at a much higher level of prerequisite work. (The formal boundary remains as a hedge against future enrollment fluctuations.)

Admission involves an inducement for students to become participants in the program, subject to satisfactory progress. The relationship is explained by Williamson's (1985) concept of asset specificity. Students must invest in substantial prerequisite courses (asset specific to a limited group of academic majors) before being admitted to the four programs. But admissions represents a program investment, so that as long as students remain in good standing they can lay claim to program resources. The question of whose assets are to be at risk (student or program) is determined somewhat by enrollment market conditions. MT is forced to invest in the student before all prerequisites are completed, while the other programs not only require completion of formal prerequisites, but in the case of PT and PA, can require additional course work and relevant work experience.

Competition among specialized programs for students cannot be a completely free market, since the university has a major interest in distributing inputs across its resources to utilize those resources to capacity. The rather high drop-out rate (approaching 50% at the baccalaureate level) represents substantial inefficiency for the institution and an issue of public policy as well. The university has devoted substantial resources to reducing attrition, but has yet to overcome the problem of too many students competing for too few spaces in some programs, while other majors remain substantially underenrolled.

Boundary setting establishes the point of interdependence with the environment and is accompanied by boundary spanning activities designed to maintain that interdependence in a manner favorable to the organization or unit. Student recruitment is a boundary spanning task. Specific activities ranged from emphasis on the distribution of printed materials and assigning peripheral staff to recruitment, in the case of favorable enrollment situations such as PT and PA, to MT core faculty serving as advisors of pre-MT students in order to insure a supply of enrollments. Other dimensions of boundary spanning include participation in professional and professional education associations concerned with the

regulatory environment and the nature of practice, and maintaining relationships with clinical sites both outside and inside the formal organization. The are discussed briefly in other sections of this report.

Curriculum as an Organizational Technology

Types of technology. Technology is the work of an organization, encompassing the processes used to produce goods and services, the resources used in those processes and the distribution of the outputs produced. Academic programs may employ alternative technologies. Adult education might be often described as a mediating technology, bringing together students and instructional resources under specified conditions much as a bank brings together lenders and borrowers. The English tutorial is an intensive technology in which each step in the instructional process is determined by information gained in previous steps, much as a hospital organizes the diagnosis and treatment of illness.

The four academic programs examined here, and most others we are reasonably certain, can be described as production technologies. Inputs are subjected to a process which transforms them into outputs. The technology can thus be differentiated into three basic stages, an input stage in which resources are acquired and prepared for processing, a transformation stage to the output desired, and an output stage in which the products are distributed or "disposed of" as the organizational literature (Thompson, 1967) phrases it. The technology of the four programs examined can further be described as long-linked, or bound by sequential relationships over time, and is composed of the initial production of standardized subparts which are then assembled in various configurations to produce more specialized products. The long-linked technology is characteristic of assembly line manufacturing. Subproduct assembly is found in the manufacture of agricultural machinery (Woodward, 1965).

Differentiation and Integration. Organizations are created so that complex work can be differentiated into specialized subtasks. The subtasks may be interdependent if a more complex product or service is to be produced, and this

interdependence must be integrated or managed if outputs are to be achieved efficiently. Management or coordination of interdependence is costly, however, and cost must be minimized if efficiency is to be maintained (Thompson, 1967). The task of organization then is to differentiate production processes to take advantage of specialization, while minimizing the interdependence among processes to keep coordination costs as low as possible.

This organizational view of curriculum is fundamentally at odds with the prevailing view based on the psychology of learning. Psychology would maximize interdependence among learning elements through principles such as sequencing and integration, while an organizational perspective would limit interdependence to the level and form necessary to accomplish the task. Examination of interdependence among courses and other learning activities provides a test of which perspective is followed in actual practice.

Progressive differentiation of specialized knowledge, and integration of the more specialized knowledge elements produced by differentiation, were the major sources of content modification in the four programs studied. (The creation of new technologies such as computerization, and the extension of professions to new areas of practice such as private practice were other major sources of differentiation in addition to direct advances in knowledge.)

Much criticism has been leveled at curriculum fragmentation. Fragmentation may instead be specialization brought about by the differentiation of general bodies of knowledge into specialized subfields yielding more powerful explanations and interventions within limited domains. The development of immunology may represent the fragmentation of chemistry and biology, but it provides more powerful insights into the functions and dysfunctions of immune systems than does molecular biology in general. Specialized subfields which explore the perimeters of disciplines may thus form fundamental linkages between disciplines more than the basic disciplines.

Forms of interdependence. Interdependence among complex tasks may take a number of forms which in turn may be coordinated or managed in several ways. Under incentives of efficiency, the forms of interdependence and the modes of coordination will be selected to minimize the cost of coordination as well as the direct cost of production (Thompson, 1967).

We found it useful to distinguish between interdependence based on epistemological linkages among knowledge elements and interdependence related to student mastery of those linkages. For the most part, and especially across academic units, coordination of interdependence among course work is limited to knowledge interdependence and was accomplished primarily by standardization of content.

Pooled interdependence. The least costly form of interdependence to coordinate is pooled interdependence (Thompson, 1967) in which activities are interdependent only as their successful completion contributes independently to some organizational task. The humanities and social science general education requirements, except for psychology in this study, represent pooled interdependence. Course work in these areas is required of all students, but is not linked in any way to more specialized courses and may be taken at any time during the program of study. (Sequential linkages among science courses force the humanities and social science courses to be taken at rather awkward times in the junior and sometimes the senior year in several of the programs.) Pooled interdependence may be coordinated by standardization, which requires no further management effort, unless exceptions arise.

Long-linked interdependence or sequencing. The major form of interdependence in the four programs and in their prerequisite courses is sequential or long-linked interdependence in which the outputs of one course or curriculum stage become the inputs for the next. Although long-linked interdependence among courses embodies sequences of learning, we found coordination among courses, across units especially, to be limited almost entirely to knowledge

interdependence and to be accomplished by standardization. Time bound interdependence requires scheduling in addition to standardization to coordinate. Time thus becomes an even more scarce resource because of scheduling constraints, and a major problem for the four programs.

Analysis of course sequences reveal the sequences to be organized and coordinated as networks of information or knowledge (Blau & Scott, 1962), and to reflect efficiency of network organization more than principles of learning. When specialized concepts are differentiated from basic concepts, they are defined initially by those basic concepts which continue to serve as the core around which specialized knowledge is organized. The resulting knowledge networks can be viewed in much the same way as information networks in organizations. Information is transmitted most efficiently through a single point and then to others, rather than through a variety of points sequentially (Scott, 1987, p. 152).

Reciprocal interdependence or integration. In addition to pooled and long-linked interdependence, activities may be mutually interdependent when the outputs of each serve as the inputs to the other. This is integration of learning as the curriculum literature typically uses that term, and is the most costly form of interdependence. Coordination requires mutual adjustment of all activities to achieved desired outcomes. We found no significant examples of concurrent or reciprocal interdependence in the four programs and their prerequisite courses. Even in courses involving concurrent didactic and clinical instruction, little attempt was made to relate concurrent experiences. Instead, experiences were sequenced to form more complex understandings, so that integration among knowledge elements developed sequentially rather than concurrently.

Interdependence and learning. Interdependence of knowledge was the major interdependence found among courses. This was true within the four programs, and across academic units to prerequisite course work and subsequently to clinical experiences at various sites. Student learning was not ignored, but was

addressed primarily when it became a problem affecting mastery of knowledge.

From an organizational perspective, problems of learning can be addressed in several ways: by allocating additional instructional resources, by adjusting subsequent tasks to reflect deficiencies in early learning, by differentiating students having difficulty with the prescribed material (e.g., physics for poets), and by selection - removing those who have not gained proficiency. Learning difficulties can also be treated as exceptions and managed on an ad hoc basis. In the four case studies, problems of learning affecting interdependence across academic units were resolved primarily by selection, and where selection would have reduced the number of student inputs unreasonably, by offering differentiated course work to accommodate those students. The university, for example, offers five different courses involving elements of calculus. The course work reflects more the differing abilities of students destined for specialized programs such as business and engineering than it does differences in the content of the courses.

In contrast to the weeding solution to learning problems across academic units, major learning problems within the four programs were likely to be treated as exceptions and managed on an ad hoc basis, or resulted in curriculum modifications if substantial numbers were involved. PT provides for reexamination of students failing a course or unit within a course. MT shifted from batch processing (one course at a time) to concurrent course work in part to allow students failing a course to repeat only that course and proceed with others, rather than having to wait until the next cycle. (Concurrent courses also allow for part-time enrollment, which addresses the enrollment problem in MT.) PA utilizes batch processing at some points. The few students failing a course are dropped from the program and must apply for readmission the next year to the point they failed.

Learning also becomes a major consideration where explanatory knowledge must be linked with techniques of intervention or action to produce professional

competence. Competence reflects individual differences and its mastery cannot be standardized to the same degree as acquisition of content. Mastery of competencies was defined almost entirely within academic units and within individual courses wherever possible. Indeed, where competence requires interdependence among two or more courses, a third course was sometimes created to achieve the linkage rather than trying to coordinate several courses through mutual adjustment.

"Introduction to Clinical Medicine," a course taken by PA students along with medical students, is the outstanding example of a course linking knowledge with competence. The course brings together medical knowledge and diagnostic techniques that might be addressed in several courses and then coordinated. Instead a course enrolling 200 students full-time for a semester was created. The course enrolls 200 students and involves over 100 faculty and instructional personnel, including trained laypersons who simulate the presenting complaints of patients and provide "clinical sites" for instruction in examination procedures, etc. The course is coordinated by a full-time, non-faculty coordinator.

Coordination costs associated with mastery of competence provide one reason why knowledge content rather than competencies, such as broader thinking skills, may be so little emphasized where they are not directly related to external demands, such as professional practice. It may also reflect institutional and program size, since coordination costs are magnified when coordination moves beyond face to face interaction.

Criteria for curriculum decision. Al though a variety of factors influence choices in development and implementing curriculums, the four case studies revealed two major criteria, action (versus explanation) and efficiency. Action and efficiency in turn reflect the nature of two basic resources, knowledge and time, employed in academic programs.

Attempts to organize knowledge modify that knowledge by emphasizing some features and ignoring and distorting others (Holzner, 1983). Knowledge for professional practice is especially difficult to develop and synthesize. The synthesis must address a conflict between two criteria in knowledge selection and organization, action or intervention on the one hand, and explanation or understanding on the other (Holzner, 1983; Sagen, 1986). Professional schools thus reflect a structural ambiguity (Light, 1983), organized as they are at the intersection of the action driven expectations of professional practice and the standards of explanation associated with the basic academic disciplines in a university.

Action is the ultimate criterion in a professional program, determining the choice among basic science and other courses whose content is governed internally by the standards of explanation. At some point, however, content governed by explanation and the knowledge arising from practice driven concerns of the field must by synthesized to some degree. This is accomplished entirely within professional course work in the four programs, thus minimizing potential conflict and other transaction costs associated with synthesizing action and explanation based knowledge (and competencies) across units.

The demand for explanatory content related to action, also influences the nature of differentiation and the relative emphases among sub areas in basic disciplines such as chemistry and mathematics. Biochemistry in the university, for example, was created out of the need for explanatory courses for medical and other health science students. The Department of Biochemistry was in turn differentiated from the chemistry department. In mathematics, the demand for statistical applications and for other areas of discrete mathematics heavily associated with the use of computers, has been one major factor in the creation of a Division of Applied Mathematics and Statistics within the mathematics department. Basic academic disciplines may be primarily the organized self-interest groups described by Clark (1983), but they are not immune from the

ultimate criterion of action and other external influences more typically associated with professional fields.

The second basic criterion in curriculum decision making is efficiency. The importance of efficiency arises from the problems of multiple tasks in some programs, and time as a scarce resource in all areas. The case for efficiency as a criterion is strengthened in situations where scarce resources must be allocated among multiple yet necessary tasks. The major example of multiple tasks occurs in the two programs where faculty are on tenure track appointments (PT and PA) and expected to meet university criteria for research as well as teaching effectiveness. Faculty in the tenure-track programs spend less than half the contact hours with students in comparable didactic courses than do the non-tenure track instructors in MT and NMT, and teach fewer courses by relying more heavily on other instructional personnel.

Critical resources. Academic programs are dependent upon a number of resource environments including knowledge, enrollments as inputs, and instructional resources such as clinical sites and faculty. Among the potential resources, two, knowledge and time, were most influential in determining the nature of the four programs. The four academic programs can be described generally as the implementation of decisions regarding the organization of knowledge and the allocation of time. Other issues such as standards of proficiency, and the need to improve learning, can be important considerations under certain conditions, but for the most part, knowledge and time were the predominant concerns.

The critical nature of knowledge is obvious in the organizational structure of the institution and in the amount of effort expended to differentiate and then coordinate knowledge for purposes of advancement and transmission. In most course work, relationships within and between courses are associated with the interdependence among elements of knowledge rather than problems of learning or other considerations.

Time is a more subtle resource in curriculum because it arrives attached to human resources. Merton (1957) notes that the field of medical education itself developed largely because of problems associated with the time demands on medical students. Two significant time related characteristics of human resources are they can only be leased not purchased, and they cannot be further disassembled and the parts worked on concurrently to permit more efficient use of time. The value of time increases in long-linked technologies where sequential scheduling of elements is added to the cost of coordination.

There was more knowledge and competency competing for student time in each of the four programs than there was time available. All programs included at least one full summer of study beyond the four years for a baccalaureate degree, and five years for a masters.

The four programs are dominated by critical long-linked paths involving progressively differentiated and specialized knowledge. The length of the longest of these paths determines the potential minimum length of an academic program. The number of concurrent paths obviously cannot exceed the number of courses taken per semester. Entry to some paths such as physics in NMT must be delayed in the prerequisite course structure until other path requirements such as chemistry are completed. This is one reason the remaining degree requirements in the humanities and social sciences must be completed wherever time is available rather than organized as a coherent program of general education. Complications associated with critical paths and the related problems such as critical filters, to be discussed later, illustrate the organizational problems of curriculum and the critical nature of knowledge and time as determinants of program structure.

Standardization. Standardization is a form of coordination and is formally considered part of the structure of organizations. It was by far the dominant form of curriculum coordination in the four programs. Standardization is so heavily related to the nature of curriculum as a technology, that it is dis-

cussed here as well as briefly in the section on structure. Standardization represents the application of systematic and universal procedures to all events within a domain. It is the least costly form of coordination, assuming that activities are of a sufficient scale and stable enough to recoup the initial investment in standardization.

Standardization of curriculum content occurs primarily at the level of the field, rather than within the organization. The health care professions and the field of chemistry speak of a year course in chemistry, and everyone in those fields can identify the general content of the course. Within the university, interviewees could typically describe the general content of science courses in other fields, though they might not know who was teaching the course or what the text was. Light (1974) refers to the academic professions as professional bureaucracies. Standardization of knowledge and of procedures for advancing that knowledge insure that everyone knows what everyone else is doing and can operate by the same general guidelines.

Standardization is a powerful influence upon technology and is one of the ways structure can be demonstrated to influence technology. Standardization becomes a criterion for curriculum decisions, much like the criteria of action and efficiency described earlier. It thus emphasizes some content, and ignores and distorts other. Standardization is also one more powerful barrier to curriculum integration across disparate fields such as the sciences and humanities, and the professions and the liberal arts. These non-routine linkages would require a different approach than the standardized course work found currently.

Compelling reasons for standardization can be observed in the four case studies. Where standardized outputs such as competent professional practitioners are to be produced, standardization of inputs and of production processes is the most efficient means to produce those outputs. (Standardized outputs are, of course, more efficient to produce in the first place.)

Standardization can be managed by the identification of exceptions. Bess

(1982) concludes that students form the integrating links across courses and curriculums. We argue that standardization is the predominant mechanism, and that students typically become important to coordination only as they fail to acquire the desired information.

Where acquisition of standardized course content is necessary to professional programs, undergraduate institutions in a competitive enrollment market can ill afford to produce exceptions. The enrollment market is thus a powerful standardizing influence, despite the claims of undergraduate programs to offer a distinctive curriculum.

Student mobility is also a major factor. As part of a state system of higher education, the four allied health programs must admit qualified applicants who transfer from community colleges and other public four year institutions. This can be accomplished only if course content is reasonably standardized across institutions.

Standardization is also an inevitable consequence of the advancement of science and its systematic application to practical affairs. Normal science is described as the systematic solution of scientific puzzles within a paradigmatic framework (Kuhn, 1963). The properties of that paradigm are reinforced and extended as standardizing elements to a variety of topics. The molecular revolution in biology resulted in a new paradigm. The paradigm in turn was extended to a myriad of problems in health care, still guided by the standardizing basic concepts of biology and chemistry.

Standardization provides some refutation of the current organizational emphasis in higher education upon "loose coupling" (Weick, 1976). Though academic units, particularly in the basic disciplines, can be demonstrated to have considerable autonomy, the ultimate criterion of action, especially when accompanied by funding for research and education, provides a powerful incentive to link bodies of knowledge. Academic units in the basic sciences appear like

regulated public utilities. Although relatively autonomous, the basic sciences are constrained by the requirement to provide necessary courses to other units, and are thus interdependent with those units.

Stages of Production. Several characteristics of academic programs as organizational technologies may be explored most easily within the framework of the stages of production described earlier. Stages were defined by variations in activities and functions, and by alternative forms of coordination within and between stages. The four programs were defined as long-linked production technologies, involving several production stages and processes interdependent over time. A production technology involves at least three basic stages, an input stage in which resources are secured and prepared for processing, a transformation stage, and an output stage in which the products are prepared for distribution.

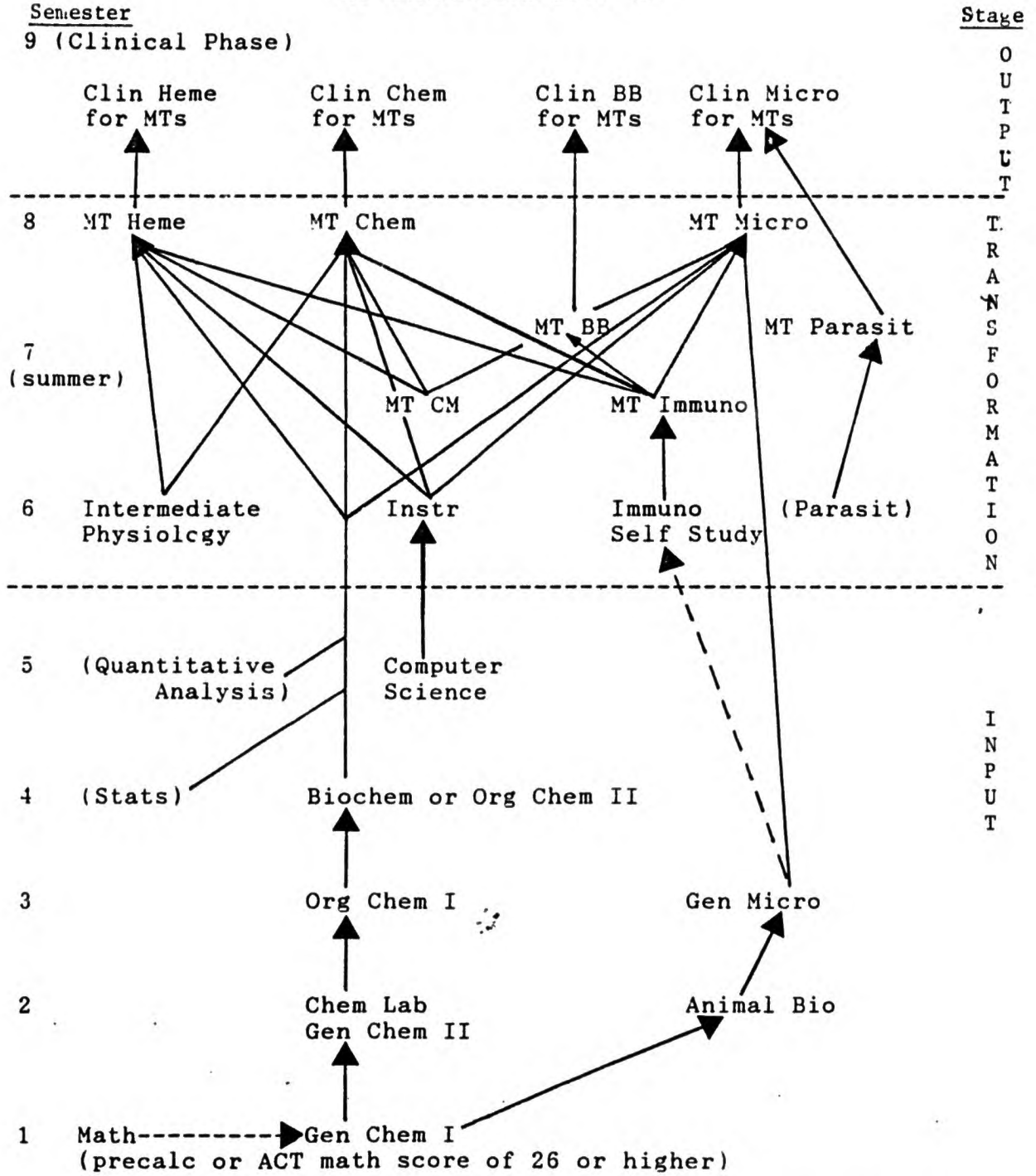
The current MT program is summarized in Figure 2 according to production stages. Similar charts were prepared for the other programs, including retrospective analyses for ten year periods to the origin of each program.

Insert Figure 2 About Here

Input stage. The input stage consists of securing resources and preparing them for processing. The production of standardized outputs is accomplished most efficiently by securing standardized inputs and subjecting them to a standardized production process. Like the output stage, the input is a boundary-spanning activity involving interdependence with the environment. Under norms of efficiency, the input stage serves both to bridge the environment to secure resources, and to buffer the core of the technology from environmental uncertainty (Thompson, 1967).

Figure 2

MT CURRICULUM 1988-90



MT required courses and their linkages. Courses in parentheses are recommended. Codes: MT=medical technology, BB=blood bank (also called immunohematology), Instr=instrumentation, CM=clinical microscopy. Source: Pre-Medical Technology Curriculum, 1989.

The problem of securing resources is related to organizational or programmatic boundary setting discussed earlier. The boundaries for the three undergraduate programs (MT, NMT, PA) are internal to the institution and vary with the enrollment position of the program.

Prospective inputs are standardized prior to admission by prerequisite courses in the basic sciences and are coded by the grades received. A few of the subproducts involve extended sequences, but the outcome is still a reasonably general resource available to a number of potential science and scientific professional majors, including all four of the allied health programs if other requirements are satisfied. The university thus operates with reasonable efficiency in maintaining students as general resources, available to a number of specialized programs.

The prerequisite course work in MT (Figure 2) includes two major critical paths created by the molecular revolution in biology and its relationship to chemistry. The chemistry emphasis ends in biochemistry, while the biology track develops subpaths to microbiology, immunology, and parasitology. The existence of these paths and subpaths precludes, for most students, the addition of a foreign language or some other sequence of courses during the prerequisite phase. The chemistry path also sets the minimum input time at four semesters.

The interdependence within course sequences is one of progressive differentiation of knowledge. We can ascertain no other reasons, such as higher order thinking skills for example, to explain such sequences. There are no horizontal or integrating linkages. Chemistry is listed as a co-requisite for biology, but this occurs because of time pressures on what is actually a prerequisite. Students acquire enough chemistry in the first several weeks to cope with the molecular content of the introductory biology course. (There is no coordination between the two courses, save for standardization.)

Critical paths were also found to be substantially related to critical filters, and these filters are primarily quantitative. Mathematics, for

example, is the filter to the chemistry sequence, either through course work or a satisfactory ACT score. We have not pursued the point in detail, but speculate that mathematics is an ability filter, rather than a knowledge filter since the ACT score cannot be associated with any major block of knowledge in mathematics. The ACT is rather interpreted as an indicator of the ability to perform reasonably complex analyses. Since, the introductory chemistry course makes few mathematical demands, the filter represents quality control on the departmental investment in a three semester course culminating in organic chemistry. We found pre-calculus mathematics for the biological sciences to function as a filter in MT and NMT in much the same manner.

The transition stage or technical core. Following successful completion of the input stage, the partially assembled set of subproducts (student) is then admitted to the transformation stage which produces the more specialized professional product. The transformation stage also constitutes the technical core of each program. The technical core of a technology is that part of the technology which has the greatest potential for improving the efficiency of the technology (Thompson, 1967). The assembly line is the technical core of much manufacturing, since it is the area where the greatest gains in productivity and hence profit are typically achieved. Organizations thus seek to buffer the technical core from environmental and other sources of uncertainty by maintaining a supply of inputs and disposing of outputs.

Academic programs may be expected to pursue efficiency in the technical core for several reasons, including the pursuit of prestige by elite programs as the equivalent of profit (Garvin, 1980). Professional course work is typically the place where time is most scarce relative to course content. It is also the area where time savings may be greatest for faculty. Faculty time is especially important to programs such as PT and PA whose faculty are expected to pursue research. The technical core is the area where the academic unit typically allocates most of its fixed resources of permanent faculty, and may be expected

to utilize those faculty most efficiently, for whatever purpose.

The technical core becomes most efficient when it can rely on a single core technology or process (Miles & Snow, 1978). This process is identified as traditional didactic instruction involving systematic knowledge but is not the sole technology in the technical core in the four programs.

Under environmental and internal requirements to produce competence, professional programs must synthesize knowledge and practice to some degree. Each of the programs introduces clinical instruction in the pre-clinical phase of the program. (This it occurs largely through simulation in MT because of the expense of clinical facilities.) Clinical instruction is costly. It cannot be standardized completely and requires more adjustive forms of coordination involving personal contact. Placing some clinical instruction in the pre clinical phase (technical core) of each program, however, contributes to overall efficiency. Confining the synthesis of explanation and action to the professional program, absolves the basic sciences from any responsibility, and eliminates the need for extensive coordination among those units. Introducing clinical instruction in the technical core also reduces program dependence on non-university clinical sites for the development of clinical competency.

The technical core is also where professional programs typically establish an action oriented knowledge base unique to the profession, the technology of the profession itself, as Toulmin (1976) defines it. The two programs (MT and PT) which originated outside the academic structure as hospital based programs, consisted originally of a pre-professional phase, more general, but not unlike the current input phase. This was followed by a year of clinical rotations interspersed with lectures, primarily on the basic sciences as they might be applied to the solution of clinical problems. The development of a systematic body of professional knowledge arose in part from differentiation in the basic sciences to form more powerful knowledge bases for specific areas. But a professional knowledge base must synthesize both the basic sciences and the system-

atic analysis of problems of practice. PT, for example, in 1959 taught the use of crutches linked in turn to some basic principles of physics. By 1969, kinesiology had been introduced, and the work with clients had been systematized as gait training. By 1979, gait training had become based on gait analysis and was incorporated into a systematic program of therapeutic exercise. The basic sciences and the techniques of practice were thus synthesized in a general technology.

The output or clinical phase. Our expectation had been that the full-time clinical rotations in each of the four programs would comprise part of the technical core because of their centrality to professional practice. Instead, we found the program faculty turning the major responsibility for clinical instruction over to clinical affiliates, restricting their own efforts to general oversight of the quality of experience for each student and to preparation for that experience through the technical core. The inclusion of limited clinical instruction in the technical core, while reducing efficiency of that core somewhat, also reduces the dependence on and need for coordination with the clinical sites to achieve professional competency.

Except for NMT which places all its students in the university complex, the other programs are forced by their size to utilize non-university clinical sites. PT places students nationally, while MT and PA placements are typically within the state. The variety in clinical placements, the emphasis on rotation through several placements, and the lack of functional control over sites, all contribute to the separation of the clinical phase from the core of instruction.

Organizational Structure

Organizations may become differentiated internally for a number of related reasons. Member self interest or the desire to reduce conflict may lead to specialization of subtasks. The environment may promote differentiation by imposing norms requiring structural elaboration, or by creating market mechanisms which lead to differentiation for reasons of efficiency.

From an efficiency perspective, differentiation should group tasks requiring the most costly forms of coordination within the primary units of the organization, with additional structure then added to coordinate the tasks remaining (Thompson, 1967). Universities are organized around differentiated bodies of knowledge to transmit and advance that knowledge. This suggests that knowledge related activities make the greatest demands upon coordination, and that other tasks such as improvement of learning will be treated as secondary problems.

Some bodies of knowledge reflect new and sometimes awkward syntheses of knowledge elements compelled by environmental demands for knowledge and competence related to important forms of action. These forms of knowledge synthesis characterize the professional programs examined here. The syntheses depend on knowledge from other fields. Interdependence with those academic units is thus established and some form of coordination required.

This view of university organization is consistent with Clark's (1983) contention that knowledge (not students) constitute the basic materials of academic work. Universities and other types of institutions as well, would be organized essentially as they are now, whether students enrolled or not. As the case studies illustrate, the major forms of interdependence and resulting coordination both within and across academic units as they relate to curriculum, are concerned with knowledge. Issues of learning, other than the appropriate knowledge to transmit, are distinctly second order coordination tasks.

The university sponsoring the four programs strongly reflects this form of organization. The four programs are organized within the College of Medicine in a Division of Associated Medical Sciences headed by an associate dean with other major responsibilities. The division is primarily a coordinating entity, though two of the programs (PT and PA) are budgeted through the Division. The sources of funds and organizational homes of faculty in the several programs reflects a bewildering array of College of Medicine and university hospital sources. MT and NMT are funded primarily through University Hospitals, while PT and PA are

funded more as free standing programs in the College of Medicine (though located in the Division).

This form of organization is long-term, although two of the programs (MT and NMT) until 1982 led to baccalaureate degrees in general science in the College of Liberal Arts. They are now B.S. degree programs in medicine, and no change in degree emphasis or structure can be found in the organizational shift. PT as a masters degree program is also organized within the Graduate College through the College of Medicine as the sponsoring unit.

The four programs are sponsored formally by the division so that curriculum changes flow from the program through the division head to the dean of the college, and in the case of PT to the graduate college. Three of the programs (MT, NMT, and PA) are required by their accreditation standards to have a medical director in charge of the medical content. PT is not subject to such controls. (The three programs are accredited by the Committee on Allied Health Education Accreditation, a standing committee of the American Medical Asssociation. PT is accredited by its own professional association.)

The formal structure is highly centralized and hierarchical, characteristics of most professional schools (Blau, 1973). Each program has a director recommended for appointment by the division head. Most of the courses in the technical core of each program have multiple instructors and are headed by a course director appointed by the program director. Curriculum changes at the program level are developed through consultation and consensus, with only PT having a formal curriculum committee structure.

This sketch of the formal structure provides background for the conclusion that the formal structure has relatively little impact on curriculum, except to establish a set of constraints within which curriculum development and implementation occur. The hierarchical structure constitutes a chain of approval and of potential vetos, but even vetos are subject to renegotiation if internal and external environmental influences prevail. The hierarchical structure also

provides a means of resolving conflict, should other planning and coordinating mechanisms fail.

Most modifications of curriculum originate in the environment through advancements in knowledge and changes in practice as we have discussed earlier. The curriculum servies as an agent of technology transfer, incorporating new developments in the profession and transmitting them to new practitioners. Changes embedded in practice and in the knowledge base of the field enter the curriculum with relatively little discretion left to program or individual faculty. Faculty as individuals and units as collectives also participate in the field, however, and their influence through research, service and association level political activity may be substantial. The degree of organization of the field is a major determinant of curriculum content, as discussed earlier, with PA heavily organized and dominated by medicine, and MT and NMT by hospitals as well. Only PT as a field has considerable autonomy, and the academic program reflects this autonomy.

Curriculum changes in the four programs occur typically through consensus and with relatively little conflict among program faculty. Differences of view are more likely to emerge where clinical affiliates play a substantial role in curriculum decisions.

One other dimension of organizational structure influencing curriculum is the formal reward and status structure of the university, especially the promotion, tenure, and compensation guidelines for tenure track faculty. Several faculty in two of the programs (PT and PA) are on tenure track appointments. Pressures for curriculum efficiency, especially in the use of faculty time, are especially substantial in programs where faculty are expected to actively engage in research.

Coordination of interdependence. Coordination of interdependence among curriculum elements so reflects the primary organization of the university around bodies of knowledge that much of the analysis of coordination has been

presented in the section on technology. The dominant form of coordination is standardization, especially at the input stage of prerequisite courses, but at other stages as well. Course linkages reflect interdependence among knowledge elements cordinated almost entirely by standardized content. Formal coordinating structures do not exist and faculty rarely meet regarding the relationships among basic science courses and between those courses and professional programs.

The other major form of coordination is scheduling, necessitated by the scarcity of time in general and particularly by the time bound interdependence of course sequences. Probably more meetings have occurred to discuss scheduling problems across academic units than to discuss the interdependence of content.

Where learning problems occur between basic science courses they are resolved almost entirely by selection; i.e., weeding out those not coded as satisfactory. What is satisfactory, however, is determined in part by enrollment supply, and these standards have fluctuated in the several programs over time.

Problems of learning in the basic sciences may also be addressed by differentiated courses for particular groups of students as discussed earlier. (The differentiated courses still retain standardization as the efficient means for coordination.) Mathematics is the major example with pre-calculus, calculus, and statistics for a number of different areas including the biological sciences. Although content is somewhat differentiated, student ability appears to play a more significant role in the establishment of the level of course work.

Interdependence among courses in the didactic portion of professional work is also managed primarily by standardized content. More adjustive forms of coordination are required to manage the relationship between didactic and clinical instruction offered by program faculty and between course work in the technical core and clinical rotations at various sites outside the university.

Clinical experience cannot be standardized as completely as knowledge. The

emphasis on competence and practice rather than knowledge acquisition further insures that individual differences among students and variations in experience will require more substantial coordination of instruction. The outstanding example is the "Introduction to Clinical Medicine" course described earlier. The logistics of the course and the occasional requirements for adjustment are so complex that a full time non-faculty course coordinator is employed.

Coordination between didactic and clinical instruction and between the program and clinical sites is more likely to involve committees and other forms of face-to-face coordination. A special problem arises in the case of PA and especially in PT where clinical rotations are offered at sites some distance from the institution. Coordination is achieved primarily after the fact through extensive debriefing of each student regarding the nature and quality of their clinical experience. Problems can then be resolved prior to the next student being sent to the site, and in some cases sites and supervisors are replaced if major problems remain.

The final form of coordination identified is coordination by exception, or the management of exceptions. Exceptions are the results of uncertainty. They arise most often from learning difficulties and from personal problems affecting individual students. Exceptions are most often allowed at later stages where the program (and student) have already made substantial investments (asset specificity), and must engage in costly ad hoc procedures to protect the investment. Some forms of exception management become relatively routinized, such as re-examination for PT students and granting of incompletes in all programs. Many exceptions can only be managed by ad hoc procedures such as additional individualized instruction for students experiencing difficulty. Management by exception is costly and is the least monitored form of coordination and the most open to abuse.

Coordination of curriculum elements in the four programs reflects a high degree of efficiency. Coordination among courses is coordinated by standardiza-

tion wherever possible, especially across academic units. Problems requiring later adjustments such as between didactic and clinical instruction are contained within the program, and indeed are grouped into a single course such as "Introduction to Clinical Medicine" wherever possible. Coordination with clinical sites is somewhat minimized by introducing clinical instruction in the technical core, thus achieving basic competence before sending students to clinical rotations. Problems of individual learning in clinical rotations are not addressed unless they become significant, and adjustments are typically made prior to the next student entering the site. Less common individual problems are managed as exceptions, especially where investment of additional resources would protect earlier investments in the student. In contrast to the integration emphasis of curriculum theory we found virtually no examples of coordination of concurrent course work. This is a costly form of coordination, requiring mutual adjustment, and is avoided by sequencing potentially integrated courses wherever possible.

Outline of a Tentative Model

The Basic Framework

The research was initiated within Scott's (1987) framework of five basic characteristics of organizations: environment, technology, structure, goals, and participants. The synthesis of four case studies of allied health programs in a comprehensive research university academic health care center leads to the outline of a more specific model, generalizable to other professional programs, and with some modification to other academic areas such as liberal arts and general education. The model is organized around three of the five original characteristics, environment, technology, and structure. Formal goals were not found to play a major role, except as compliance with environmental regulatory norms. Research on participants has not been emphasized to this point, and is a major next stage in the research program.

The Environments of Academic Programs

Types of environments. Organizations are interdependent with their environments for the acquisition of necessary resources, the disposition of products and services, and legitimation which allows organizations to function with support and without undue interference. The types of environments interdependent with academic programs include output environments, resource environments, regulatory environments, and input environments. Environments may be potentially internal as well as external and since institutions are somewhat loose federations, the relationships among units and the internal environment may resemble more that of the interorganizational field.

Dimensions of environments. Environments may be described as institutionally elaborated or technical-market oriented (Meyer, Scott, & Deal, 1981). Some environments, such as the regulatory, emphasize the organizational elaboration of broader societal values and norms. Other environments such as the input (enrollment), represent exchange relationships governed typically by market mechanisms. Most environments are mixed, with enrollment markets themselves institutionally elaborated, and regulatory environments not immune from market influences. The adaptive response to institutionally elaborated environments such as accreditation is conformity, at least in structural, with the environment (sometimes accompanied by decoupling of structure from the actual work of the organization). The response to a market environment is efficiency if the organization is to remain competitive in that environment. We found the basic outline of professional programs to be shaped by institutionally elaborated mechanisms, but the specific content and structure to be influenced substantially by technical-market considerations.

Output environments. The output environment for professional programs is primarily the external domain of practice, characterized by a technology of practice and a related social structure. The domain for the four allied health programs represents an elaboration of the social institution of health care

within which the professions function. The domain of practice has been changed substantially, however, by new technical advances stemming from developments in basic knowledge, such as the molecular revolution in biology and consequently health care, and more technical advances, such as the use of computer and electronic instrumentation. The social structure of practice embodies market mechanisms, such as freedom of choice for consumers, and includes the social structure of employment (organizational versus private practice) and the degree of organization and concentration among employers and other clients.

Regulatory environments. Regulatory environments include the external environments of accreditation, licensure--certification, and a general-legal environment of other laws and social regulations. Accreditation and licensure-certification are heavily influenced by the organizational set of the profession and of competing programs preparing for the profession, which must cooperate as well as compete to establish regulations in their mutual self interest. The organizational set also characterizes an internal regulatory environment consisting of mechanisms such as degree structures, which are the product of relationships among academic programs as well as the elaboration of external norms.

Resource environments. Resource environments include the knowledge base of the program, human resources of faculty and staff, and other instructional resources such as the university health care center and other off-campus clinical sites. The resource environment is both external and internal. Individual academic programs may not have the human resources to draw on knowledge bases outside the institution, and access to internal knowledge may be influenced by the internal monolopy for instruction granted to several academic disciplines.

Input (enrollment) environments. The inputs of academic programs are students. Input environments, both external and internal, consist of students competing for places in desired programs, and institutions and programs competing for students. Both internal and external enrollment markets are institutionally elaborated to some degree. Institutions seek to utilize their

resources efficiently by distributing students across program resources through devices,such as general education,and through filters which encourage movement into certain specialized programs and limit access to others. The external market is constrained to some degree by mechanisms,such as articulation agreements and system wide regulations,which may encourage or limit student choice.

Boundary Setting and Boundary Spanning

Public institutions of higher learning have relatively less autonomy in establishing boundaries than industrial and other private sector organizations. Nevertheless, decisions to add programs lead to interdependence with new output environments and to new enrollment markets. Boundary setting and accompanying boundary spanning activities reflect the interdependence of the organization with its environment and the degree of uncertainty associated with the ability of the organization to secure resources and distribute its products in those environments. Greater interdependence through boundary spanning may be sought to reduce uncertainty. We found this evident in admissions standards and in practices designed to promote enrollment, even at some cost to the quality of students enrolled.

Curriculum as an Organizational Technology

Production technologies. The technology of an organization includes the processes used in production of goods and services, the resources utilized in that production, and the methods of distributing or otherwise disposing of outputs. Academic programs may well employ alternative technologies. We conclude that most curriculums can be described as production technologies emphasizing the utilization of standardized subproducts (prerequisite courses) in the early stages, coupled with more distinctive production processes, such as clinical instruction, to produce a specialized product (graduate).

Stages of production. The production technology of specialized professional programs comprises an input stage of pre-professional basic science

course work in which students are standardized by prerequisite courses and quality coded by grades, a transformation stage of professional course work that builds upon the standardized subproducts of basic science courses to produce a more specific professional product, and the output stage of clinical experiences which prepare the student for the specifics of practice in the output environment they are likely to enter. The input and output stages are boundary spanning. They represent the requirements to bridge the program with its input environment to secure resources, and with the output environment to distribute the product. Simultaneously, however, these boundary spanning stages must protect or buffer the technical core of the program from the uncertainty associated with quantity and quality of inputs and the market demand for outputs.

Differentiation and integration. An organizational technology represents the differentiation of complex work to take advantage of specialization, coupled with the need to integrate that work because of the interdependence among differentiated elements required to produce a desired product. Academic institutions are differentiated primarily around bodies of knowledge. The primary interdependencies within and between units is associated with the interdependence within and between those bodies of knowledge. (We cite this form of differentiation to emphasize that the primary linkages among elements in the curriculum are concerned with knowledge, not with learning. The linkages would presumably be the same, if no one enrolled.)

The technology of professional programs is substantially long-linked. This reflects the progressive differentiation of courses over a time bound sequence beginning with the basic sciences and progressively differentiating into more specialized sub-areas and then to related professional course work.

Critical resources. The organizational problems of long-linked curriculums are often related to knowledge and time as the two major resource requirements. Knowledge represents the primary material of academic work (Clark, 1983) and forms the core of the technology, as well as the primary form of institutional

organization. The selection of knowledge content in professional programs is governed by the ultimate criterion of action; i.e., relevance to professional practice. The ultimate criterion of action influences not only the selection of clinical and didactic professional content, but the choice among basic science courses based on their eventual linkage to professional course work. This procedure allows the basic sciences to be governed by their criterion of explanation, but presents a problem for professional course work which must link explanation and action (the structural ambiguity problem of the professional school itself, according to Light, 1983). We also found the knowledge requirements for action to affect the internal structure and relative emphases in basic science units such as chemistry and mathematics.

The second resource, time, is a fundamental property of human resources which are typically leased by the program in an exchange relationship with the student (and faculty members also). There is more potential content than available time in professional programs, and content is constrained by the number of subjects an individual can address concurrently (a substantial learning consideration). The sequential nature of basic and specialized professional course work creates critical paths which dominate the curriculum schedule and preclude other linkages such as the integration of concurrent course work advocated by many curriculum theorists.

Efficiency. Perhaps the pivotal conception in our tentative organizational model of curriculum is efficiency. Efficiency is defined as any increase in net benefits (benefits less cost) and is the expected response of organizations to market competition. Efficiency need not be based upon market mechanisms, however (McMahon, 1982). Efficiency can be promoted by institutionally elaborated norms where multiple necessary tasks are imposed and priorities among those tasks established, where scarce resources such as time must be distributed across tasks, and where a control system monitors task performance. These conditions describe at least some aspects of institutions, even in the absence of

market mechanisms. We found efficiency considerations to be especially dominant in the programs involving tenure track faculty whose multiple tasks include research as well as instruction, and whose performance is monitored by an internal reward structure, as well as by an external professional environment.

Coordination. Curriculum efficiency depends not only on controlling direct instructional costs such as time, but also the coordinating (Thompson, 1967) or transaction (Williamson, 1985) costs of managing the necessary interdependence among components of the curriculum.

Standardization. The outstanding example of efficiency in the current research is standardization of curriculum content. Standardization is the least costly structural means of coordination among interdependent elements. Everyone can be aware of what everyone else is doing and can function accordingly. Academic professions are thus organized somewhat as professional bureaucracies (Light, 1974).

Standardization dominates curriculum content in the basic science input stage. The long-linked progression from basic to specialized science to professional studies further influences standardization since the outputs of early courses serve as inputs to more specialized work. Standardization also reflects the coordination requirements of a system of higher education characterized by a high degree of student and faculty mobility between institutions and student mobility between programs within institutions.

Interdependence and learning. Efficiency is also a dominant consideration in the finding that interdependence involving learning (as distinct from interdependence related to content) is held to a minimum, especially between academic units. If curriculums were to promote the sequential development of complex cognitive competencies, for example, other forms of coordination among courses would have to be employed. Competency reflects individual differences to some degree and cannot be as standardized as content. The development of competencies is typically confined within academic units and indeed to limited

course work within each program. More extensive linkages would involve substantial coordination costs. Efforts to promote competency development across units, such as the recent emphasis on writing across the curriculum, reflect these problems of coordination among academic units.

Interdependence associated with learning is also minimized between units by addressing learning difficulties as matters of selection at the next step, rather than as problems to be shared among courses and academic units. We also found critical filters, such as mathematics, to be placed as prerequisites to critical paths, such as chemistry, to minimize the investment in students who might complete initial course work, but fail in later stages of the sequence.

Structure

Technology and structure. The relationship between technology and structure has not been resolved by organizational research (Scott, 1987). Our study reflects this difficulty by suggesting ways in which structure might influence technology and vice versa, and by suggesting that both are substantially influenced by environments. The literature (Scott, 1987) also indicates that structure and technology are most likely to be related at the technical or work level of the organization. Our case studies likewise focused on this level.

Universities are knowledge advancing and knowledge transmitting organizations. Not surprisingly, they are organized primarily around bodies of interdependent knowledge. Universities then concentrate coordination efforts within and between these primary units on the management of knowledge interdependence (accomplished primarily, by standardization of knowledge content).

Other problems of curricular interdependence requiring coordination, including problems associated with student learning, are treated as lower order concerns for which additional coordinating mechanisms may be established if needed. But coordination of these additional tasks is more difficult and potentially far more costly where it must cross the primary organizational lines. As

noted earlier, problems of learning are thus typically confined within academic units and even within more limited course structures where they may be addressed through personal contact.

Coordination of curricular interdependence is accomplished in ways generally consistent with principles of efficiency, as described earlier (Thompson, 1967). Instructional interdependence itself is generally held to the minimum needed to accomplish an educational task, rather than being maximized as psychological principles of learning would infer. Interdependence, especially across untis, is limited to knowledge interdependence which can be coordinated by standardization. Where course linkages involved sequencing (time-bound), scheduling is added to standardization as the next lowest cost form of coordination. Integration of concurrent courses, which would require reciprocal adjustment among those courses, is avoided as too costly.

Problems of learning are addressed by selection in the input stage. Where sufficient professional enrollments cannot be generated from standard basic science courses, differentiated course work is established. Problems of learning within the professional program are more likely to be addressed directly because of the resource investment by program and students at that point. Problems affecting individual students, the product of uncertainty, are likely to be managed as exceptions, even at considerable cost of effort to the faculty involved.

Task and reward structures. Major additional structural sources of influence on the curriculum include institutional task structures and reward structures. The task structure in universities may include research and often service, as well as teaching; and the reward and status structure of the organization often assigns higher priority to research than instruction. An organizational model predicts that under pressures for efficiency, instruction will be organized as a joint product of research and instruction, with the same knowledge base used for both wherever possible. Potential conflicts between the

roduction functions of research and instruction will be resolved according to the priorities of each in the reward structure. The reward structure for individual faculty appears to be the major mechanism for internal institutional control as it relates to instruction. Not surprisingly, curricula developed largely through faculty efforts reflect the priorities established by the reward system.

Formal structure. We did not find traditional curriculum approval structures such as committees and faculty votes to play a significant role in our case studies. Nor did formal administrative structure except as a chain of potential vetoes, subject almost always to renegotiation. We ascribe this to the dominant influence of the external environment in professional programs, and to the coordination and change mechanisms found in academic fields which substantially determine curriculum structure and content within institutions. We would expect internal mechanisms to be more significant in areas such as general education, where the products of these courses are consumed internally rather than distributed directly to the external environment.

Discussion

We began with the proposition that curriculum can be more adequately explained, and perhaps even improved, by considering it as an organizational phenomenon rather than a plan for individual learning. The issue, we suggest, is more specifically one of appropriate levels of analysis for various types of curriculum questions. The product produced by a curriculum, however, is the individual graduate. Eventually an organizational conception must link with questions of individual learning.

Curriculum is defined as an organizational technology, the work of the organization. One major question, is whose work, students or faculty, is likely to assume priority in the development of academic programs? A satisfactory explanation of curriculum must initially address, the knowledge advancing and transmitting work of faculty. That work constitutes the technical core

of the organization and reflects the advantages of faculty specialization into fields of knowledge and the internal organization around those fields.

From this perspective, the structure and technology of universities can be seen as mutually supporting and reasonably efficient. Structure and technology address the joint tasks of advancing and transmitting specialized knowledge, and assume that the major interdependencies among individual faculty and units are associated with the interdependence of knowledge. Other forms of interdependence, such as learning, are minimized or are considered entirely within the primary academic units to control coordination costs.

Structure and technology become inconsistent when confronted by interdependencies such as broader learning experiences that cannot be readily coordinated by existing structure. Bess (1982) proposes a matrix form of organization as the solution to this problem. Matrix organizations are associated with changing tasks. The tasks of universities are rather more stable. A matrix form of organization entails substantial coordination costs and other inefficiencies resulting from separation of the joint production fuctions of research and instruction. Matrix organizations represent a potential solution to some types of curriculum problems, however, and Bess's analyses and proposals strengthen our contention that an organizational conception represents the most effective approach to curriculum.

Whether one believes the current emphases of academic institutions are efficient and adaptive or misguided and pathological, the major sources of curricular improvement may be those of organizational structure and technology rather than of individual learning. Analysts of American business (Hayes & Abernathy, 1983) reach the parallel conclusion that the potential for improvement in efficiency and effectiveness in modern corporations is rather marginal at the level of individual productivity, compared with the potential for

improvements addressing organizational structure and process. While not abandoning efforts to improve individual learning, higher education curriculum might benefit from an emphasis on more complex organizational technology and structure issues as well.

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