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TOWARDS A SYSTEM OF PROFESSIONAL EDUCATION

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The process of model building, now formally identified with the discipline of systems theory, has recently been making significant contributions to tidying up and advancing such areas as management science, economics, defense systems, and physiological systems Before any kind of models can be built, foundations must be laid in terms of both verbal description of the problem and some sort of block diagram representation Only after work has been completed at these two stages can General Systems Theory bring its tools to help either a computer simulation or a detailed mathematical model of a particular system This paper is concerned with the first two stages approaches to verbal description and diagrammatic representation of the problems of an educational system

The purpose of this paper is to explore some of the ingredients that will be, pre-requisite to a systems-theory approach to an educational system The discussion of these ingredients will, therefore, be rather general, but it is hoped that these initial gropings will eventually lead to an analytic (quantitative) model amenable to modification and mathematical manipulation Before such a model, or set of models, based upon the mathematical systems theory of Mesarovic (2), is even feasible, it will be necessary for educators and all those who are interested in the educational process to develop a much more rigorous approach to defining variables and studying the process itself

It is assumed that a school can be viewed as a goal-seeking system, i e, it has been established to produce transformations in students The student enters the system with certain characteristics, call them X, and through a series of transformations, call them Z, the system and the student interact until these transformations are completed, call them Y Over-simplifying, the system transforms X into Y by means of Z as shown in Figure 1 The problem then, is to develop a greater understanding of this system by examining, X, Y, and Z more critically

The characteristics of the student upon entering the system, X, are discussed first, followed by a brief discussion of the methods available for transformation, Z The transformations themselves, Y, are treated at length because they are so important and plagued with difficulty It is a strange phenomenon that although the transformations (Y) or goals of an

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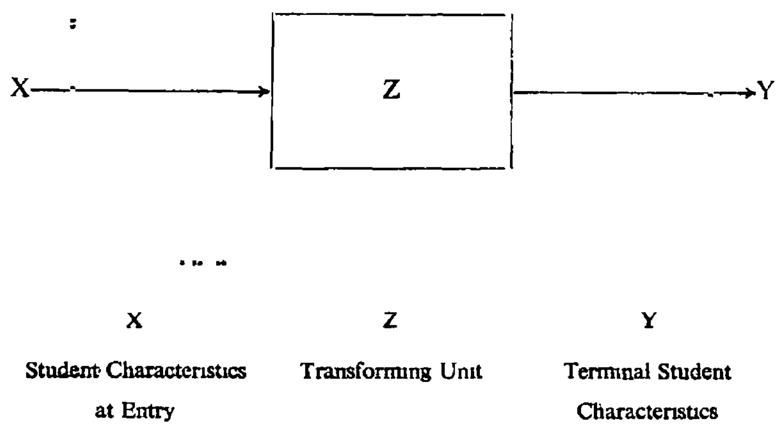
FIGURE 1

SCHOOL AS A TRANSFORMATION SYSTEM



educational system demand logical priority, they are usually psychologically last It is an amazing although consistent occurrence that serious discussion of goals is short-lived and often swamped in waves of operational and logistic considerations Before the problems of planning programmes, evaluation, and system constraints are considered, a systematic approach to establishing educational goals is discussed at length

CHARACTERISTICS OF THE STUDENT AT ENTRY (X)

The input unit to the system is the individual student and because he is a human being 'he should not be spindled folded, or mutilated' * Each student can be identified by certain qualities and characteristics Certain student characteristics are definable, such as aptitudes and grade point average, while other student characteristics such as motivational level and personality traits, can only be approximately described Nevertheless, selection of students for the system is usually contingent upon the extent to which applicants possess these attributes in the judgement of admissions officers

The process begins therefore when the student enters the system and it cannot be overemphasized that the student is not just being passively

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processed by the system, but takes an active role in shaping his own growth and development

CHARACTERISTICS OF TRANSFORMING UNIT (Z)

The transforming or central processing unit of a professional school consists of both resources and operations Teachers, students, laboratories, libraries, equipment and ancillary personnel could all be regarded as resources Operations consist of formal and informal interaction among the students and between student and other resources Formal operations consist of courses of study including laboratory sessions and conferences Informal operations would be the more casual interactions with fellow students and faculty members The function of these resources and operations is to produce change in the students For this reason the really important changes should be carefully identified and directly linked to particular operations designed specifically to produce these changes They should not be left to incidental or chance learning experiences nor to maturation or other haphazard circumstances The function of the central processing unit then, is to produce change in the student, especially those changes which represent the development of competencies that the student did not already have when he entered the system

CHARACTERISTICS OF STUDENT AT FINISH (Y)

A major problem in developing an educational system is to identify and define those changes to be produced in each student Certain changes such as a change in the fund of factual information or competence in the use of such information, can probably be well-defined because there is some way of showing at the output stage whether a student possesses these competencies at an acceptable level Other changes, especially in affective attributes, are more difficult to define, at least in a way that makes it possible to assess their development It is imperative, therefore, that the system remain open with regard to these 'hard to assess competencies' and that researchers get on with what will probably have to be an iterative approach to defining and assessing these more evasive competencies

Establishing priorities

Just because a competency has been defined does not mean that it is necessarily important and, conversely difficulty in defining a competency is no excuse for excluding it from consideration

Once desirable changes in competency have been identified and defined, priorities must be established among them for the simple reason that the time dimension is finite Assume for a moment that a set of competencies has been defined and each definition has been recorded on a card Consider a few of the dimensions according to which priorities might be established The teaching staff could sort these competencies from low to high priority in terms of several criteria For instance, they might sort from low to high priority in order to determine the extent to which the present system attempts to develop these competencies Another sort might assess the extent to which the present system succeeds in developing these competencies to an acceptable level A third sort might establish the order of importance of these competencies in terms of an ideal educational system, a system with no constraints A fourth sort might attempt a logical ordering or clustering of these competencies in terms of some principle of structure or theory of the subject matter (1) The criterion of increased leverage for learning other skills might also be considered in order to insure integration and sequential development In short, any useful criterion could be employed as a basis for sorting and the results of such sorts could be objectively and quantitatively described in such a way that areas of high agreement or disagreement would be apparent Since painless machinery for settling conflict and disagreements has yet to be developed, final decisions would have to be made through the usual discussion-debate process It is likely, however, that a quantified delineation of the issues would temper the usual emotionalism of group-decision process

Depth of understanding

Once priorities among competencies have been established, it is soon evident that any given competency can be supported by a pyramid of fundamental knowledge whose base is potentially infinite Each competency, therefore, has a depth dimension Consider the basic science foundation or a particular skill in clinical medicine The foundation has an almost bottomless base of background knowledge and may be laid with varying degrees of depth This base is potentially infinite because any aspect could justify a lifetime of scholarship It is obviously impossible to support each competency with its complete foundation If complete depth is impossible, how shall an 'adequate' or 'acceptable' cut-off be established?

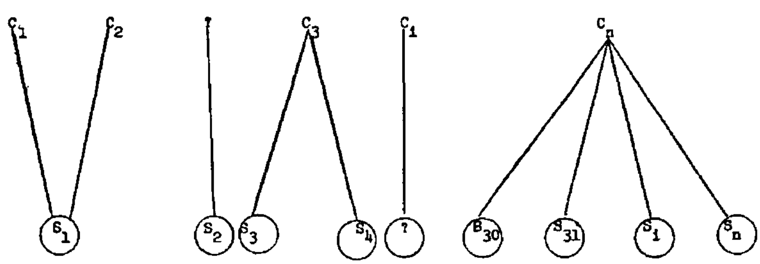
An iterative approach might work For example, one professor of medicine claims he has a method of training high school graduates to read and interpret electrocardiographic records in such a way that it is impossible to differentiate the interpretation produced by the novice from that of an expert However, it is quite clear that the depth of understanding would be quite different for the two Neither the expert nor the novice possesses the depth dimension at a precisely 'adequate' level One base is too shallow, the other too deep Although errors of the second kind are more tolerable, it is preposterous to attempt to develop graduates who are expert in every field However, a clear statement of the two extremes should guide the process of mapping the foggy middle ground of 'adequacy' or 'appropriateness'

Programmes planning

What provisions have been made to develop these competencies? The existing system can be examined with this question in mind If the term 'subroutine' is used to describe that component of the transforming unit whose function it is to develop specific competencies, the links between terminal competencies and subroutines can be mapped, as shown in Figure 2 In the process of mapping these connections it is possible to uncover missing links such as 'competency, no subroutine', and 'subroutine, no competency'

FIGURE 2

LINKING COMPETENCIES TO SUBROUTINES



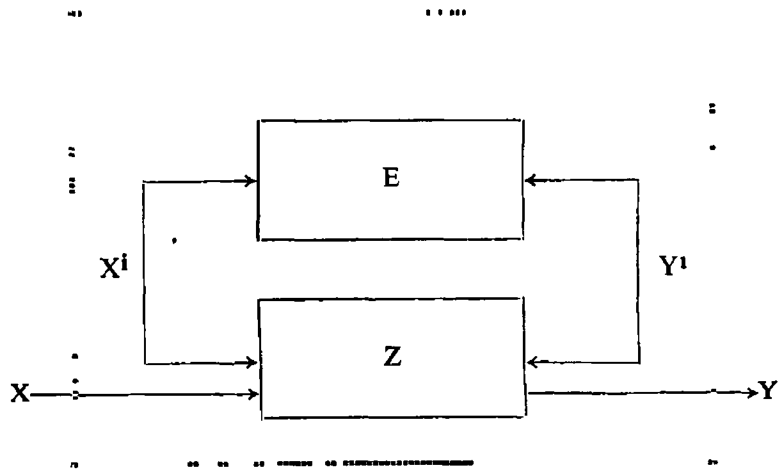
C – change in competency upon completion of professional school
S – subroutine, the function of which is to produce changes in competency

An instance of a 'competency, no subroutine' might be a clearly agreed upon competency for whose development no explicit provisions have been made All teachers might agree, for example, that a Ph D is basically a research degree and implies a whole set of research skills, such as the ability to recognize and to define a problem and to execute a study designed to answer that problem Aside from the requirements of a doctoral dissertation, however, a survey of most universities would show that there is very little opportunity for students to develop these skills This may help to explain why so many doctoral candidates fail to complete their dissertations

An instance of a 'subroutine, no competency' is also possible It is not uncommon that formal and explicit provisions for the development of competencies linger long after the competencies are outmoded Again, a

FIGURE 3

SCHOOL AS A TRANSFORMATION SYSTEM



X	Z	Y
Student Characteristics	Transforming Unit Resources	Student Transformation
Aptitudes	Faculty	New Knowledge
Previous Achievement	Library	New Skills
Attitudes	Other Students	New Attitudes
Values	Equipment	New Values
Interests	Laboratories	New Interests
etc.	etc	etc
	Operations	
	Courses	
	Seminars	
	Study Groups	
	Projects	
	etc	
E = Evaluation Unit	X^1 = Intermediate Characteristics	Y^1 = Intermediate Transformation

survey of practising researchers in many disciplines would probably reveal that in most cases the foreign language requirement for an advanced degree serves no purpose, yet, almost all institutions hold fast to this requirement

THE EVALUATION UNIT (E)

The purpose of evaluation is to monitor the system and to insure quality control Is the transforming unit, Z, doing its job? Is it producing the kinds of outcomes for which the subroutines within it have been designed? To answer these questions a decision or evaluation unit is needed to pass judgement on a continual basis upon the effectiveness of the system The evaluation unit, E, is shown in Figure 3 The intermediate transformations or competencies are fed into it for judgement and the consequent evaluation data are fed back to the transforming unit for appropriate action

Insofar as students are transformed by the central processing unit so that the desired competencies have been developed to an acceptable level, to that extent the system is fulfilling its function Insofar as these changes, do not occur, to that extent the system has failed Furthermore since there are many alternative ways to develop and to reinforce these changes there would be many corresponding opportunities for educational experimentation as attempts to design an optimal system would be encouraged

It is obvious that this system is never static Data from the Evaluation unit are fed back to the Transforming unit and indicate the kinds of alterations in subroutines or even the kinds of inputs that may be necessary For instance there may be certain personality or attitudinal changes which are simply not attainable within the present system Either an individual would be required to possess these characteristics before entering the system or experimental programmes would have to be devised to research the possibilities of developing such characteristics in specially selected individuals who did not possess them upon entering the system The results of such research would either broaden or restrict the range of possible candidates

Someone may object that there are simply too many competencies to identify, define and enumerate There may be hundreds, or even thousands Furthermore, this approach tends to atomize the educational process

This may be the price of precision It is not always possible to insure integration of sub-competencies Furthermore, the 'good doctor', the 'good lawyer', the 'good social worker', who is often the goal of professional education, will always be more than the sum of the defined competencies Besides the limitations of the definitions of those competencies that can be identified, there are some concepts not yet ready for definition There is the danger, then, of excluding those ill-defined competencies from the system On the other hand precision about the educational process should buy all sorts of new opportunities for integrating the entire process as well as for locating shortcomings and gaps Without sound evaluation it is impossible to distinguish the spiral of progress from the merry-go-round of tail-chasing

If competencies are not defined, how can the system insure their development, and how can the success of the system be evaluated? The possibility of very large numbers of competencies should not discourage attempts to identify and define them A space programme, for instance, is a very complex system and it would be absurd to believe that such a system could organize itself even if subsystems, such as the electronic industry were well organized Similarly the development of a new automobile requires the definition of hundreds of finite manufacturing specifications Fortunately students are self-corrective and self-adaptive, and can often identify and provide for their own development However, priority competencies should not be left to haphazard, incidental, or random learning experiences Being explicit should in no way conflict with student responsibility and initiative

If the competencies expected of the student are made explicit to the student he may proceed on his own initiative to attain and even go beyond the basic requirements The student may then show insight judgement and efficiency in selecting and working through subroutines on his own or even develop his own subroutines The implications for preparing students for a lifetime of learning are clear

CONSTRAINTS

As with any system educational systems have constraints Perhaps the chief constraints facing professional schools are time, the environment for learning the cost of education the willingness of a faculty to soul-search and the degree of openness to which a system can be left without premature closure If one recognises these constraints and utilizes them in a manner similar to the architect's careful utilization of building materials it should be possible to design a workable system

Under the present system time is a major constraint In most professional schools time is fixed at two, three or four years Perhaps it can be made more flexible, expanding or contracting, depending upon the needs of the individual student and the aims of the system In any event, time cannot be overlooked because it is obvious that no one can learn everything about a profession in a fixed length of time If this constraint is overlooked, subroutines may be designed to build skyscrapers when the budget of time is barely adequate for a cottage Within certain broad limits there is merit in thinking about time as a variable rather than a constant This allows the lock-step to be broken

The educational environment is a somewhat open and ill-defined variable but insofar as it describes the quality of interaction between the input variables and the system itself, the environment must be considered primary at all stages of planning and operating the system Faculty attitudes, for instance, are crucial Little can be done to implement this system if faculty attitudes towards change are not positive The whole system is based upon a philosophy of change This does not mean adopting fads or innovations for their own sake, but rather changes that have been carefully considered and, where possible, based upon data and real needs It is possible that a transition from change based upon fad to change based upon data could be a major stimulus to the development of the positive faculty attitudes

If the budget is a major constraint it would seem all the more imperative that the system undergo a careful scrutiny in order to insure maximum use of existing funds Can modern methods of accounting, cost analysis, resource allocation theory and operations research assist in the development of an optimal system?

One final caution — more precise definition of desired changes and closer evaluation of the system expose the system to premature closure It is imperative therefore to recognize the limitations in both definitions and evaluation, and although complete definition and evaluation remain the ideal, the system must remain open until such time that the ideal is attainable

It is hoped that these rather simple concepts, although difficult to implement, may answer two questions that students continually ask what does the faculty believe is the most important and how am I doing?

REFERENCES

1 FURST, J E Task of evaluation in an experimental economics course *Journal of Educational Measurement* 1966, III, 213 8

2 MESAROVIC M D General Systems Theory and its mathematical foundation Paper presented at the *1967 Systems Science and Cybernetics Conference*, IEEE, Boston, Massachusetts, October, 1967