DOCUMENT RESUME

ED 227 584 EA 015 507

AUTHOR Gaynor, Alan K.
TITLE The Dynamics of Stability and Change in Public Schools.
PUB DATE [81]
NOTE 29p.
PUB TYPE Reports - Research/Technical (143) -- Viewpoints (120)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Change Agents; *Educational Change; *Educational Innovation; Educational Research; Elementary Secondary Education; Mathematical Models; Organizational Theories; Predictor Variables; Simulation; Systems Approach
IDENTIFIERS Leadership Effectiveness; *Public School Change Model; System Dynamics Approach

ABSTRACT

Despite substantial efforts to stimulate innovation in the public schools, little long-term change has been noted by observers. No firm data have been obtained to describe the innovative behavior of school systems longitudinally. The extensive literature has reinforced a permutational view of educational change as dependent on the given situation's particular mix of a seemingly infinite number of discrete factors. Using the system dynamics approach, the author of this report constructed a mathematical model representing a dynamic theory of educational innovation and used the model to examine the impact of alternative policies on the effectiveness of innovation efforts. The resulting Public School Change Model aggregated many of the factors identified in the literature into a relatively small number of variables, including conflict, the level of innovation, external funding, linkage, the educational norms of administrators, teachers, and the community, and, most importantly, leadership effectiveness. The development of the model was guided by the metatheoretical proposition that the behavior of systems over time is determined by the interplay among relevant positive and negative feedback structures, three of which affect this model. This report describes the model, the theory behind it, and the nature and results of simulations testing it. (PGD)

# THE DYNAMICS OF STABILITY AND CHANGE IN PUBLIC SCHOOLS

Alan K. Gaynor
Educational Leadership Program
Boston University

## The Problem

Despite substantial and well-publicized efforts to effect change in the public schools, schools have been found by observers to be not very different over long periods of time.

Unfortunately, there are no firm data which describe longitudinally the innovative behavior of public school systems. Data on implementation are poor; those on discontinuation are almost non-existent. As a result of the data deficiencies, not only can no clear explanations be made, but no firm interpretations can be put forth about the nature of the problem, itself. For example, two researchers, in arguing that most innovations have been "blunted on the classroom door," have suggested that schools, over time, are essentially non-innovative (Goodlad and Klein, 1970).

Case studies, as well as common experiences, however, suggest that the depiction of public schools as statically non-innovative may represent neither a valid nor a useful problem perspective. For at least twenty years, large amounts of effort and resources have been allocated at all levels of government to bring about change in schools. It seems inconceivable that these efforts have been without even temporary effect.

## Research Objectives

The thrust of an extensive literature on educational change has been to portray the force field of educational innovation in strongly disaggregate form. Case studies and theoretical reviews have reinforced a permutational view of educational change. According to this view, the success or failure of an innovation is dependent upon the particular mix of a seemingly infinite

number of discrete factors.

This richness of detail is useful. However, the fundamental weakness of the existing literature is its inability to explain in directly comprehensible terms the long-term behavior of educational systems with respect to innovation. The focus of the empirical work has been upon innovativeness in the short range. Most of the research has focused upon discrete innovations and has not sought to document patterns of innovation over long time frames.

It has been the intent of the current work to reexamine contextually assumptions which derive from the case literature on innovation in public school systems and to reassess the utility of the "managerial perspective" which has marked most writings about the persistent failure of planned efforts to alter the programs, clients, services, organization and instructional methods of public schools. There has been a deliberate attempt in pursuing this work to embed the "management" of schools in a socio-political context.

Results suggest a clearer understanding of the relationship among different strategies for changing schools. They also help to clarify the dimensions of leadership effectiveness. The latter has important implications for the training and selection of school administrators.

## The Meaning of Innovation

Consistent with the purposes described, innovation is defined broadly. Within the theory presented, innovation refers to the presence in school systems of relatively non-traditional curricula, services, clients, or methods and organizations for instruction.

Such innovative practices stand in contrast to more modal historical practices. Examples in recent decades might include the least restrictive provision of services to exceptional students, racially and ethnically integrated educational programs, community schools incorporating programs for

atypical client populations, multi-unit organization for instruction, individualized instruction, and non-traditional inclusion of boys and girls in programs such as athletics and industrial arts. Traditional practices might be seen to include more segregated distributions of students, self-contained classrooms, the limiting of school services to school age children, and emphasis in the curriculum on traditional subject matter.

## Methods

The project has represented an effort to give coherence to the case literature on planned educational change (see, for example, Baldridge and Deal, 1975, pp.389-523; Herriott and Gross, 1979; Weiser, 1976; and Wolcott, 1977). What these studies suggest is that there is a generically definable set of factors which interact to affect over time the processes of implementation and discontinuation of innovative programs. In each case study details are described which are situationally unique. However, there appears common to all of these case descriptions a broadly definable set of dynamics. The methodological approach has been to identify a relatively small set of broadly-defined variables and to describe systematically relationships among these variables which are hypothesized to account for long-term patterns of innovation in schools.

Relationships among variables have been described mathematically in the form of a continuous computer simulation model. The particular approach to model formulation has been that of System Dynamics (Forrester, 1968). Particular emphasis has been placed on describing the feedback links which order interactions among elements over time. In fact, the study has been guided by the meta-theoretical proposition that the behavior of systems over time can best be understood in terms of the interplay among relevant positive and negative feedback structures.

The model has been tested by subjecting it to a variety of extreme

conditions. This has been done by systematically employing exogenous inputs to place unusual upward pressure on one or more model variables. The model appears to be robust in this regard. Tests were also made to assess the sensitivity of the model to modifications in table values. Here, too, the model seems robust, generally insensitive to such alterations.

The essence of the system dynamics method is to construct a mathematical model to represent a dynamic theory of a problem and then to use the model to examine the dynamics of alternative policies with respect to the problem. In effect, the model is formulated, tested and then used to generate policy data. Model generated data can be useful for two purposes: (1) to compare the behavior of the model against known historical trends and (2) to understand and assess the comparative utility of alternative policies to deal with the problem.

Several policies were examined in the course of the study. Firstly, a number of model runs were made to assess the relative impact upon patterns of innovation over time of changes in external funding, linkage, leader norms, and leadership effectiveness. These factors were examined individually and in various combinations. Tests were also run to assess the impact of changing community norms and to understand the unique contributions to innovation of several dimensions of leadership effectiveness. These included the effects of leadership effectiveness on the level of innovation, in reducing conflict, on teacher norms, on community norms, on external funding, and on linkage.

## The Dynamic Hypothesis

Central to system dynamics modeling is the formulation of a broad hypothesis about the interaction over time of the major feedback structures which constitute the problem system. In common parlance, this enables the analyst to "see the forest for the trees." The process of developing the dynamic hypothesis removes the theoretical discussion from the level of

chronology and discrete variables and focuses it upon the interplay of a relatively few crucial feedback loops [1].

The dynamic hypothesis which guided the formulation of the Public School Change Model derived from an extensive review of the literature on organizational change (Gaynor, 1977) and particularly from reflection on available case descriptions in the educational arena. In this section of the paper, the dynamic hypothesis is put forth without substantial discussion. The meanings of particular relationships and the reasoning behind their assertion are discussed more fully in a later section which deals with the model sector by sector (Infra, pp. 8 ff.).

According to this hypothesis, three major feedback structures--one positive and two negative--operate to control patterns of innovation in public schools. Positive feedback is centered mainly in a set of interactions involving innovation, funding, linkage, leadership effectiveness, along with leader, teacher and community norms (see Fig. 1). This feedback subsystem is consistent with historical policies of government and private agencies which have been predicated on the belief that external funding, leadership training, and networking provide significant leverage in stimulating and supporting school reform.

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[1] Feedback structures are of two general types. So-called "positive" feedback structures include causal relationships among variables which are mutually self-reinforcing. The relationship between wages and prices operates within the dynamics of inflation and depression to illustrate the concept of positive feedback. "Negative" feedback structures are characterized by their goal-seeking behavior. A thermostat system, for example, is a negative feedback system. In such a system, the effect of one variable on another is the opposite of the countereffect of the second variable upon the first. In the thermostat system, the heater goes on as the temperature goes down and off as the temperature goes up. Whereas positive feedback systems are characterized by runaway behavior such as inflation, negative feedback systems tend to stabilize values around a goal, such as the thermostat setting.

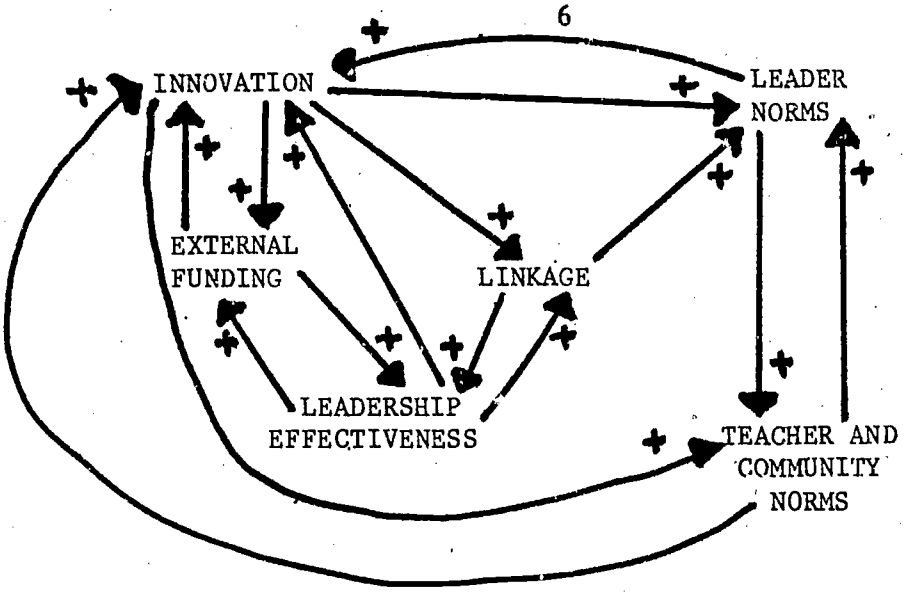


Fig. 1. Positive Feedback Subsystem. [2]

The remainder of the theory embodied in the simulation model suggests that the failure of educational reform historically does not necessarily invalidate that belief. Rather it suggests that the belief is less wrong than it is inadequate. It is proposed that there are two additional major feedback subsystems which almost universally work to counter innovation and maintain stability of programs and organizational structures in school districts over time (see Fig. 2).

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[2] Each arrow indicates a causal relationship between two variables. It indicates that a change in the first variable (at the tail) will produce a change in the second variable (at the head). The positive and negative signs at the arrowheads are used to indicate the nature of the relationship. A positive sign (+) signifies a direct relationship, a negative sign (-) an inverse relationship. Signs in parentheses within each loop are used to indicate the polarity of the loop. A positive sign [(+)] signifies a positive feedback loop; a negative sign [(-)] signifies a negative feedback loop.

Causal-loop diagrams depict highly aggregate relationships, usually mainly among state variables. The specific shape of relationships among variables are defined in the model parameters, especially in the table functions. The reader who is interested in obtaining information at this level of precision should examine these parameters. Selected parameters are discussed in a later section of this paper. A copy of the full model program is available on request from the author:

Prof. Alan K. Gaynor
Boston University School of Education
605 Commonwealth Avenue, Room 601
Boston, MA 02215

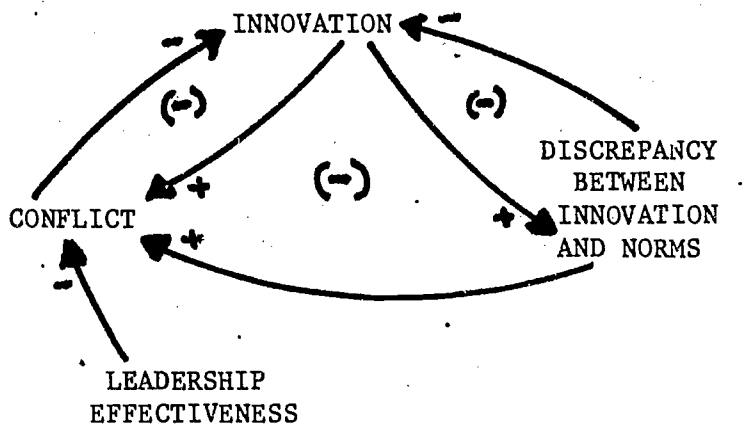


Fig. 2. Negative feedback subsystems.

The first of these operates around the generation of conflict due largely to workload and to the role disturbances implicit in the process of innovation. The second is energized by the violation of professional and community norms typically engendered by altering the status quo. This takes the form of erosion of political support for innovation and is manifested in political action. Both dynamics have the effect of constraining the rate of innovation and of exacerbating the rate of discontinuation of innovative practices already in place.

In sum, then, the dynamic hypothesis proposes that innovation generates its own constraining forces which tend to maintain school services, clients, programs and patterns of organization within a fairly narrow zone of variation over long periods of time. This is a theoretical depiction of public schools as stable cybernetic systems.

## The Model

The model stands as a mathematical representation of a theory of innovation in public schools. Unlike many system dynamics models, it seeks to represent a set of relationships common to public school districts in general. By contrast, most system dynamics models seek to portray the elements of a problem system unique to a particular social or organizational setting during a particular historical period. The essence of the position taken in seeking

to effect the former rather than the latter is that although, indeed, there are conditions idiosyncratic to each school system, it is also important to recognize powerful common elements across school systems. These common elements have to do with the technical, organizational and social realities of innovation in complex systems as well as the pervasive power of professional norms across schools (Lortie, 1975) and of community norms for institutions such as public schools which are dependent upon taxpayer support (McCarty and Ramsey, 1971).

The model has been formulated to include eight sectors. Each sector defines the factors which produce change over time in the value of a major element in the theoretical system. In system dynamics terminology each of these major elements is conceptualized as a "state" variable. Thus, the model is comprised of eight state variables: (1) Level of Innovation, (2) Leadership Effectiveness, (3) Conflict, (4) Professional Norms, (5) Leader Norms, (6) Community Norms, (7) External Funding, and (8) Linkage. [3]

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[3] It may be important to point out, from a systems perspective, that although there is normally a variable of interest (e.g., Level of Innovation in this case), this does not translate into the experimental design concept of the "dependent variable." That kind of translation requires a shift in perspective. When from a policy perspective, for example, the question is asked, "What should be done to increase the level of innovation over time?", the implicit search is for a "treatment" (an "independent" variable) which will impact in predictable ways on a "condition" (a "dependent" variable). Notice, though, that the "treatment" takes the form of an action taken outside of the problem system.

The implications of this line of reasoning are crucial. There are no "treatments" within the system and, therefore, there are no "independent" and "dependent" variables within the system. There are only mutually dependent variables within the system. In fact, this set of mutually dependent variables is the system. Or, more accurately, from an epistemological perspective, this set of mutually dependent variables is what is conceived of as the system from the particular theoretical position. Indeed, the system is the theory.

One more implication flows from this logic which helps to put into perspective one of the persistent problems of policy analysis. Policy analysts, including system dynamicists, typically produce, as a result of their work, recommendations for policies to ameliorate pressing social and organizational problems. Normally, such recommendations are based upon systematic analyses of problem systems. Not unusually they constitute logically compelling courses of action from within the boundaries of the

In providing what must of necessity be a brief description and discussion of the model particulars, the following format is followed. A section will be devoted to each state variable. The rate equation(s) will be given followed by a brief discussion of the meaning of the equation and its rationale. [4]

Level of Innovation

R IILOI.K=(((IIILN.K/IFLNAT.K)+(IIIPN.K/IFPNAT.K)
+(IIICN.K/IFCNAT.K))*EIIC.K*EIIEF.K), where:

IILOI = INDICATED INCREASE IN THE LEVEL OF INNOVATION (UNITS/YR),
IIILN = INDICATED INCREASE IN THE LEVEL OF INNOVATION FROM LEADER NORMS (UNITS),
IFLNAT = INNOVATION FROM LEADER NORMS ADJUSTMENT TIME (YRS),
IIIPN = INDICATED INCREASE IN THE LEVEL OF INNOVATION FROM PROFESSIONAL NORMS (UNITS),
IFPNAT = INNOVATION FROM PROFESSIONAL NORMS ADJUSTMENT TIME (YRS),
IIICN = INDICATED INCREASE IN THE LEVEL OF INNOVATION FROM COMMUNITY NORMS (UNITS),
IFCNAT = INNOVATION FROM COMMUNITY NORMS ADJUSTMENT TIME (YRS),
EIIC = EFFECT ON INCREASE IN INNOVATION OF CONFLICT (DIM) [5], and
EIIEF = EFFECT ON INCREASE IN INNOVATION OF EXTERNAL

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system analyzed. But since the "treatments" (i.e., the policies) must be enacted outside of the problem system, there is nothing in the analysis which addresses the problem of enacting and implementing the recommended policies.

In a certain sense this can be seen as the "fatal flaw" of policy analysis. The flaw appears to be rooted in its central epistemology. That is, the systems analyst finds himself in an epistemological hall of mirrors. There is always one more system to be analyzed.

[4] Throughout these discussions, statements will be made describing relationships among variables (i.e., their effects upon one another). The tendency is to reiterate phrases such as, "The theory asserts . . ." and, "According to the theory . . . ." Every effort has been made to resist this tendency. However, the reader should keep in mind that the entire exposition is theoretical. What is described is, in essence, an extended hypothesis about the nature of the system of innovation in United States public schools.

[5] The abbreviation "DIM" stands for "Dimensionless." A variable is dimensionless when it is a pure number, usually a multiplier. Such a number is not associated with any unit of measure. Typical units of physical measure are miles or miles per hour, for example. The model contains units of measure which are not physical units but, rather, are units on arbitrary scales (e.g., units of innovation or units of conflict). Although variables such as conflict and innovation are measured in arbitrary units instead of physical units, they are not dimensionless. Neither are their rates (e.g., rate of conflict) which are measured in units per year. Dimensionless variables are pure numbers. They are measured on neither physical nor arbitrary scales.

FUNDING (DIM), and

R IDLOI.K=(((IDILN.K/IFLNAT.K)+(IDIPN.K/IFPNAT.K)
+(IDICN.K/IFCNAT.K))*EDIC.K), where:

IDLOI = INDICATED DECREASE IN THE LEVEL OF INNOVATION (UNITS/YR),
IDILN = INDICATED DECREASE IN THE LEVEL OF INNOVATION FROM LEADER NORMS (UNITS),
IFLNAT = INNOVATION FROM LEADER NORMS ADJUSTMENT TIME (YRS),
IDIPN = INDICATED DECREASE IN THE LEVEL OF INNOVATION FROM PROFESSIONAL NORMS (UNITS),
IFPNAT = INNOVATION FROM PROFESSIONAL NORMS ADJUSTMENT TIME (YRS),
IDICN = INDICATED DECREASE IN THE LEVEL OF INNOVATION FROM COMMUNITY NORMS (UNITS),
IFCNAT = INNOVATION FROM COMMUNITY NORMS ADJUSTMENT TIME (YRS), and
EDIC = EFFECT ON DECREASE IN INNOVATION OF CONFLICT (DIM).

As described in these two rate equations, the rates of implementing and discontinuing innovative practices are driven by the set of joint discrepancies between the level of innovation at any particular point in time and leader, professional and community norms (cf., Herriott and Gross, 1979; Weiser, 1976; Wolcott, 1977). Norms function as "Desired Levels of Innovation" and, indeed, are expressed in precisely the same units as the Level of Innovation.

Pressure is exerted to close each discrepancy in its own adjustment time (normal adjustment times = 3, 3 and 5 years, respectively). Furthermore, normal adjustment times are modified by other factors. The adjustment time from leader-generated pressures is affected by the level of leadership effectiveness. The adjustment times to respond to professional and community pressures depend, also, upon the respective levels of organized resistance among teachers and taxpayers. This, in turn, is dependent on the degree of discrepancy between existing practice and existing norms at any point in time. The effect of these variable adjustment times is to alter the relative impact on changes in innovation among teachers, leaders, and taxpayers under different conditions across time. [6]

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[6] This dynamic is effected through the adjustment times associated with the Level of Innovation (see Supra, pp. 9-10, for the equations defining the

Increases in innovation are further affected by levels of conflict and external funding. Funding tends to enhance increases in innovation. Conflict, however, has a parabolic effect: initial increases in conflict above the normal level improve the climate for innovation (based upon Lewin's theory of "unfreezing"); however, levels of conflict which are greater than two-and-a-half times normal produce strong and increasingly negative effects on innovation. This seems consistent with the anecdotal histories provided in the case literature on educational innovation (Baldridge and Deal, 1975; Weiser, 1976; Wolcott, 1977).

The rate of discontinuation (Decrease in Innovation) represents essentially a mirror image of the factors which generate increases in innovation. Discontinuation, like implementation, is responsive to the prevailing norms and to pressures which determine how quickly that response takes place. Levels of conflict which are more than double the normal level produce positive effects on discontinuation. This effect becomes exponential as conflict approaches and exceeds four times the normal level.

Leadership Effectiveness

A PLE.K=(NLE*(ELEOL.K+ELEOF.K), where:

PLE = PROJECTED LEADERSHIP EFFECTIVENESS (UNITS)
NLE = NORMAL LEADERSHIP EFFECTIVENESS (UNITS)
ELEOL = EFFECT ON LEADERSHIP EFFECTIVENESS OF LINKAGE (DIM), and
ELEOF = EFFECT ON LEADERSHIP EFFECTIVENESS OF FUNDING (DIM).

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rates of increase and decrease in the Level of Innovation). The Level of Innovation is changed over time by adjusting it to the additive effects of discrepancies between the current Level of Innovation and leader, professional, and community norms, respectively.

The immediate impact of any one of those discrepancies on the overall rate of change is the quotient of the particular discrepancy and the associated adjustment time. Thus, the effective impact of each discrepancy on the rate of innovation is inversely related to its associated adjustment time. Thus, the relative impact on changes in the Level of Innovation of leaders, teachers, and taxpayers is a function, at any point in time, of the size of their respective discrepancies and adjustment times.

The theory expressed here is that leadership effectiveness is a function of normal effectiveness and the joint effects of linkage and funding. Changes in leadership effectiveness are generated by pressure to close whatever discrepancy may exist between the present level of leadership effectiveness and the projected level. This takes place in the model over an adjustment time of four years.

History has shown clear connections between linkage and innovation. Commercial centers have tended to become the frontiers of change; backwater communities have tended to remain relatively underdeveloped. Similarly, studies of the characteristics of "early adopters" in a variety of fields from agriculture and medicine to education suggest that such persons tend often to be at the center of social interaction (Carlson, 1965; Rogers, 1962)

The clear implication of such research is that leadership which is effective in bringing about innovation is leadership which is sufficiently well-connected to be knowledgeable of promising practices and to be able to attract the fiscal and technical resources necessary to plan and implement new programs. The assumption is also built into the model that the availability of external funds enhances leadership effectiveness. The idea is that these external funds provide resources to support leader initiatives and to employ larger numbers of more competent leaders.

Conflict

A PC.K=((PCFDIN.K+PCFROI.K+PCFLOI.K+PCFPS.K)*ELEIRC.K), where:

PC = PROJECTED CONFLICT (UNITS)
PCFDIN = PROJECTED CONFLICT FROM DISCREPANCIES IN NORMS (UNITS)
PCFROI = PROJECTED CONFLICT FROM THE RATE OF INNOVATION (UNITS)
PCFLOI = PROJECTED CONFLICT FROM DISCREPANCIES BETWEEN NORMS AND THE LEVEL OF INNOVATION (UNITS)
PCFPS = PROJECTED CONFLICT FROM POLITICAL SUPPORT (UNITS), and
ELEIRC = EFFECT OF LEADERSHIP EFFECTIVENESS IN REDUCING CONFLICT (DIM).

The theory asserts that conflict derives from four sources: (1) discrepancies between leader and other norms (professional and community), (2) the rate of increase in innovation, (3) discrepancies between the state of the educational program (Level of Innovation) and leader, professional and community norms, and (4) from lack of political support among teachers and taxpayers. [7] The case literature seems to suggest clearly such multiple sources of conflict, deriving both from differences in values among different constituencies and from the process of innovation, itself.

With respect to the latter, innovation tends to carry with it almost universally a number of characteristics which energize conflict. Firstly, it usually necessitates significantly intensified workloads, at least for some initial period of time. It also typically requires personnel to modify their work roles, often entailing the learning of new skills, frequently fraught with anxiety and resistance. Furthermore, it is not unusual for innovations to require new working arrangements and new work schedules. These can be disruptive of established work and friendship groups and dysfunctionally interactive for individuals with obligations embodied in other roles (multiple role conflict).

Norms

There are three sectors of the model which deal with norms: (1) Professional Norms, (2) Leader Norms, and (3) Community Norms. These are dealt with in a single section of the paper because they are so similar in their structure and so related theoretically.

A IPN.K=(LN.K*WLNPN.K+CN.K*WCNPN+LOI.K*WEPPN)/(WLNPN.K

[7] Political Support is calculated as the sum of adjusted discrepancies of teachers and taxpayers, respectively, with the current level of innovation. Adjusted discrepancies equal discrepancies divided by their respective adjustment times. Negative political support is a source of conflict.

+WCNPN+WEPPN), where:

IPN = INDICATED PROFESSIONAL NORMS (UNITS),
LN = LEADER NORMS (UNITS),
WLNPN = WEIGHT FOR THE EFFECT OF LEADER NORMS ON PROFESSIONAL NORMS (DIM),
CN = COMMUNITY NORMS (UNITS),
WCNPN = WEIGHT FOR THE EFFECT OF COMMUNITY NORMS ON PROFESSIONAL NORMS (DIM),
LOI = LEVEL OF INNOVATION (UNITS), and
WEPPN = WEIGHT FOR THE EFFECT OF THE EDUCATIONAL PROGRAM ON PROFESSIONAL NORMS (DIM), and

A ILN.K=((PN.K*WPNLN+CN.K*WCNLN.K+LOI.K*WEPLN)/(WPNLN+WCNLN.K+WEPLN))+ELNOL.K, where:

ILN = INDICATED LEADER NORMS (UNITS),
PN = PROFESSIONAL NORMS (UNITS),
WPNLN = WEIGHT FOR THE EFFECT OF PROFESSIONAL NORMS ON LEADER NORMS (DIM),
CN = COMMUNITY NORMS (UNITS),
WCNLN = WEIGHT FOR THE EFFECT OF COMMUNITY NORMS ON LEADER NORMS (DIM),
LOI = LEVEL OF INNOVATION (UNITS),
WEPLN = WEIGHT FOR THE EFFECT OF PROFESSIONAL NORMS ON LEADER NORMS (DIM), and
ELNOL = EFFECT ON LEADER NORMS OF LINKAGE (UNITS).

A ICN.K=(PN.K*WPNCN+LN.K*WLNCN.K+LOI.K*WECN)/(WPNCN+WLNCN.K+WECN), where:

ICN = INDICATED COMMUNITY NORMS (UNITS),
PN = PROFESSIONAL NORMS (UNITS),
WPNCN = WEIGHT FOR THE EFFECT OF PROFESSIONAL NORMS ON COMMUNITY NORMS (DIM),
LN = LEADER NORMS (UNITS),
WLNCN = WEIGHT FOR THE EFFECT OF LEADER NORMS ON COMMUNITY NORMS (DIM),
LOI = LEVEL OF INNOVATION (UNITS), and
WECN = WEIGHT FOR THE EFFECT OF THE EDUCATIONAL PROGRAM ON COMMUNITY NORMS (DIM).

These equations manifest the idea that all three consituencies influence one another and that all three are influenced by the current state of the existing program and organization. However, these influences are not necessarily of equal strength. Just as the gravitational fields of the earth and the moon represent mutual but unequal forces, it is similarly true that the educational leadership in a school system and the citizenry of the community mutually influence one another's educational attitudes, values and beliefs, but not necessarily equally. Different factors affect the relative

strength of these influence patterns. For example, the more effective the leadership is (in terms of the variety of skills that consitute the morphology of effective leadership), the greater its relative influence on teachers and taxpayers. From another perspective, though, the further leader norms and the further the educational program move from professional and community norms, the greater the degree of organized resistance on the part of teachers and citizens. And the greater their level of organized resistance, the greater the relative influence of those constituencies on the policies and programs of the schools.

Thus, although effective leaders have considerable potential to influence teachers and taxpayers, it is still community norms that are ultimately the strongest of the three. The political reality is that if the educational values of particular superintendents and school board members get too far out of line with community norms, it is the leadership which is replaced, not the community. Thus, communities tend to get, and deserve, not only the schools they want but the leaders they want, as well. The research evidence on this may not be crystal clear; however, the relationships described in the model seem consistent with the literature on patterns of influence in school districts (cf., McCarty and Ramsey, 1971).

External Funding

A PEF.K=(PFFLOI.K+PFFROI.K+PFFL.K)*EFLE.K, where:

PEF = PROJECTED EXTERNAL FUNDING (UNITS),
PFFROI = PROJECTED EXTERNAL FUNDING FROM THE RATE OF INNOVATION (UNITS),
PFFLOI = PROJECTED EXTERNAL FUNDING FROM THE LEVEL OF INNOVATION (UNITS),
PFFL = PROJECTED EXTERNAL FUNDING FROM LINKAGE (UNITS), and
EFLE = EFFECT ON FUNDING OF LEADERSHIP EFFECTIVENESS.

Four factors affect changes in the level of external funding. The first idea incorporated in this piece of the model is that districts which are more innovative are more likely, all else being equal, to attract more external

funding. Known research speaks not at all to this issue although common observation suggests that it is so. The theory suggests that there exists a similar relationship between external funding and the current rate of innovation. It proposes that the more actively innovative a district at any particular point in time, the more likely it is to acquire external funding.

The model further asserts that external funding opportunities are enhanced by linkage. The more school district personnel are embedded in various professional networks (with other school districts, universities, state departments of education, R&D centers, educational laboratories, intermediate agencies, etc.) the greater the likelihood for developing, recognizing and capitalizing on funding opportunities. As it has been said, "It's not always what you know, but whom you know."

Finally, the theory with respect to external funding takes the position that leadership effectiveness enhances the likelihood of obtaining fiscal support from outside the district. Skills of needs assessment, planning and proposal development seem critical dimensions of leadership effectiveness in this regard, as well as those of project management and evaluation, both necessary to establish an effective "track record." These skills are, of course, at least partially independent of those associated with linkage.

Linkage

A PL.K=PLFLE.K+PLFLOI.K+PLFROI.K, where:

PL = PROJECTED LINKAGE (UNITS),
PLFLE = PROJECTED LINKAGE FROM LEADERSHIP EFFECTIVENESS (UNITS),
PLFLOI = PROJECTED LINKAGE FROM THE LEVEL OF INNOVATION (UNITS), and
PLFROI = PROJECTED LINKAGE FROM THE RATE OF INNOVATION (UNITS).

The thesis here is similar to that explicated above with respect to external funding. Effective leaders are linkers. By definition, they possess

the interpersonal, political, and entrepreneurial skills which enable them to make effective professional connections. Leaders at the highest levels of effectiveness are those with the kind of vision and professional knowledge that attract others to their ideas and which enable them to understand the broader implications of others' work.

Furthermore, it is suggested that both the general innovativeness of the school district and its current levels of ongoing activity provide a focus for the interest of others with professional concerns. Again, this seems consistent with the research on the social interaction of early adopters (Carlson, 1965; Rogers, 1962).

## Results

### Leader Norms, Leadership Effectiveness, Linkage, and External Funding

Tests were designed to examine the relative effectiveness of traditional policies for changing schools. These included various combinations of increasing external funding, raising leader norms, improving leadership effectiveness, and expanding linkage. [8] Runs were also made to simulate mandated changes in the level of innovation, itself (for example, as the

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[8] The following table lists the normal (initial) values for the eight state variables in the model:

LOI = 25 (Level of Innovation)
LE = 25 (Leadership Effectiveness)
C = 10 (Conflict)
PN = 25 (Professional Norms)
LN = 25 (Leader Norms)
CN = 25 (Community Norms)
EF = 10 (External Funding)
L = 10 (Linkage)

It is uniformly true that when a state variable has a value at any point in time which is equal to its normal value, it has no effect on any other variable.

result of court-ordered reforms). Results are shown in Table 1, below. [9]

| POLICY VARIABLE(S) | CHANGE | YEARS | FINAL VALUES BASEMODE=EQUILIBRIUM BASE | TEST | % | FINAL VALUES BASEMODE=NOISE BASE | TEST | % |
|---|---|---|---|---|---|---|---|---|
| EF | STEP=10 | 1975- | 25.0 | 25.0 | 0.0 | 25.9 | 25.9 | 0.0 |
| EF | STEP=10 | 1975-90 | 25.0 | 25.0 | 0.0 | 25.9 | 25.9 | 0.0 |
| L | STEP=10 | 1975- | 25.0 | 25.7 | 2.8 | 25.9 | 27.0 | 4.2 |
| L | STEP=10 | 1975-90 | 25.0 | 25.4 | 1.6 | 25.9 | 25.9 | 0.0 |
| EF,L | STEP=10 | 1975- | 25.0 | 26.8 | 7.2 | 25.9 | 27.5 | 6.2 |
| EF,L | STEP=10 | 1975-90 | 25.0 | 25.6 | 2.4 | 25.9 | 26.0 | 0.4 |
| LE | STEP=25 | 1975- | 25.0 | 30.7 | 22.8 | 25.9 | 31.0 | 19.7 |
| LE | STEP=25 | 1975-90 | 25.0 | 25.4 | 1.6 | 25.9 | 26.3 | 1.5 |
| LE<br>EF | STEP=25<br>STEP=10 | 1975- | 25.0 | 32.0 | 28.0 | 25.9 | 32.3 | 24.7 |
| LE<br>EF | STEP=25<br>STEP=10 | 1975-90 | 25.0 | 25.6 | 2.4 | 25.9 | 26.4 | 1.9 |
| LE<br>L | STEP=10 | 1975- | 25.0 | 35.9 | 43.6 | 25.9 | 35.0 | 35.1 |
| LE<br>L | STEP=25<br>STEP=10 | 1975-90 | 25.0 | 27.4 | 9.6 | 25.9 | 27.4 | 5.8 |
| LE<br>L, EF | STEP=25<br>STEP=10 | 1975- | 25.0 | 37.8 | 51.2 | 25.9 | 37.3 | 44.0 |
| LE<br>L, EF | STEP=25<br>STEP=10 | 1975-90 | 25.0 | 27.8 | 11.2 | 25.9 | 27.6 | 6.6 |
| LN | RAMP=.3 TO 50 | 1975- | 25.0 | 27.9 | 11.6 | 25.9 | 27.2 | 5.0 |

[9] Model runs uniformly simulated a fifty year time period (1970-2020). Test inputs were always initiated in 1975. Some test inputs continued for the remainder of the run (1975-2020); others were cut off after fifteen years (1975-1990). The intent here was to simulate the differential effects of "permanent" input modifications vs temporary ones. The time frames of the test inputs are shown in Column 3 of Table 1 and in Column 1 of Tables 2-4.

| POLICY VARIABLE(S) | CHANGE | YEARS | FINAL VALUES BASEMODE=EQUILIBRIUM BASE | TEST | % | FINAL VALUES BASEMODE=NOISE BASE | TEST | % |
|---|---|---|---|---|---|---|---|---|
| LN | RAMP=.3 TO 50 | 1975-90 | 25.0 | 25.4 | 1.6 | 25.9 | 26.2 | 1.2 |
| CN | RAMP=.3 TO 50 | 1975- | 25.0 | 42.5 | 70.0 | 25.9 | 41.8 | 61.4 |
| LOI | STEP=25 | 1975- | 25.0 | 35.9 | 43.6 | 25.9 | 36.4 | 40.5 |
| LOI | STEP=25 | 1975-90 | 25.0 | 26.5 | 6.0 | 25.9 | 27.3 | 5.4 |

Table 1. Public School Change Model: Policy Test Data.

It should be pointed out that in each case the step value has been set equal to the "normal" (initial) value of the variable. Table functions specifying the effects on other variables of External Funding, Linkage, Leadership Effectiveness, and Level of Innovation are written in terms of the ratio between a present value and the normal value. Thus, each step increase used in the policy tests is equal to one normalized unit of that variable.

A clear implication of the theory as it is represented in the model is that schools can be brought to change in significant degree only under continuous pressure from the outside. Key elements in maintaining innovation are those which are most deeply embedded in the positive loops which drive innovation or which ameliorate the effects of the negative loops (e.g., leadership activity which reduces conflict or which alters the norms of teachers and taxpayers). Of particular importance here are leadership effectiveness and linkage, especially in combination. External funding, alone, seems to have little effect on gains in innovation. It simply doesn't have the impact on changing values and ameliorating conflict that leadership effectiveness and linkage do (see also Infra, pp. 20-22, for a further discussion of related model dynamics).

Leadership Effectiveness

Leadership effectiveness is especially important because of its multiple effects on the system. The following table (Table 2) shows the results of some tests that were run on the model to evaluate the relative importance with respect to innovation of various leadership functions.

| Test Description | Final Value of LOI |
|---|---|
| BASE RUN: Step Increase in Leadership Effectiveness (25), External Funding (10), and Linkage (10) | 37.7 |
| PARTIAL OUT THE IMPACT OF LEADERSHIP EFFECTIVENESS ON: | |
| Community Norms | 36.4 |
| Professional Norms | 36.1 |
| Innovation | 35.4 |
| External Funding | 34.6 |
| Conflict Resolution | 30.9 |
| Linkage | 25.0 |

Table 2. Comparative Impact on the Final Level of Innovation of Partialling Out Different Dimensions of Leadership Effectiveness.

Since it was found that innovation was most enhanced by multiple efforts to improve linkage, external funding, and leadership effectiveness, tests were run in that context to determine which dimensions of leadership effectiveness were most crucial to sustained innovation.

Each test involved partialling out the impact of leadership effectiveness on one of six other variables in the model (see Table 2). Estimates of the relative impact of these different aspects of leadership effectiveness were

made by examining the final values for Level of Innovation under the different test conditions. It will be noted, for example, that the greatest differences between base and test runs were achieved when the effects of leadership effectiveness on (1) linkage and (2) conflict resolution were partialled out (by neutralizing the relevant table function in each case). Other dimensions of leadership effectiveness had little impact on the final level of innovation in these test runs.

How can these results be accounted for? First, when the effect of leadership effectiveness on linkage is eliminated, what happens is that, despite the step increase, the system fails to achieve a high level of linkage. Without high levels of linkage, leader norms don't change. Whereas in the base run leader norms, altered by high levels of linkage, then exert pressure on professional and community norms, as well as on innovation, this does not occur in the test run. Without changes in norms, innovation cannot and does not occur. This is central to the theory expressed in the model. In the base condition, by contrast, linkage does begin to put upward pressure on leader norms which then draw the system into the upward drive of the positive feedback loops (see Fig. 1, supra, p. 6).

Awareness of the linkage dynamic and its effect, along with external funding and leadership effectiveness, in triggering gains in innovation, underscores the subsequent importance of conflict, and conflict resolution, in the dynamics of innovation. When the effects of leadership effectiveness in resolving conflict are partialled out of the model, conflict, under upward pressure from innovation and a growing discrepancy among norms, rises rapidly to very high levels. Under the base condition, for example, the level of conflict rises to 26.8 (where it is constrained by effective leadership). In the test situation in which the conflict resolving dimension of leadership effectiveness is removed, conflict rises to 49.1. At such a level, its impact in slowing innovation and speeding discontinuation becomes severe.

The partialling out of other aspects of leadership effectiveness--on innovation, external funding, professional and community norms--have minimal effects on the dynamics of innovation because they are almost entirely compensated for by the system. In the test cases, external funding is pulled upwards by rising rates and levels of innovation; professional and community norms are drawn higher by leader norms, mainly, and by rising levels of innovation. It should be noted, though, that leadership effectiveness has other links in the model to professional and community norms through its impact on the adjustment times controlling the influence of leader norms on the norms of these other constituencies. These remained uncontrolled during the course of the test runs discussed above.

Externally Mandated Reform

Tests were also run to examine the dynamics of externally imposed innovation (e.g., court-mandated reform). Results indicate that such intervention can have significant effects, assuming that it can be enforced over long periods of time (see Table 3). Two problems can be seen with this approach to educational reform, however. Firstly, it is unlikely that a serious mandate in opposition to community, professional, and leader norms can be maintained for periods of even five years or longer (viz., the Boston Desegregation Case). Secondly, this approach tends to produce relatively high levels of conflict (again, see Table 3). The theory seems to suggest that the likely effects of attempts to impose an external mandate are (1) some positive effects at reform accompanied by high levels of conflict, (2) the waning of the mandate after a number of years, and (3) the return of the system to a condition substantially similar to the status quo ante. It appears from the model behavior that the negative loops associated with conflict and political action sustain their conservative strength even over substantial periods of time.

| | | CONFLICT | |
|---|---|---|---|
| POLICY VARIABLE(S) | LOI (FINAL VALUE) | HIGH | END |
| STEP LOI = 25 | 35.9 | 33.6 | 30.3 |
| STEP LOI = 50 | 39.2 | 40.3 | 37.3 |
| STEP LOI = 75 | 41.0 | 43.3 | 41.7 |
| STEP LOI = 25 (1975-90) | 26.5 | 33.6 | 10.1 |
| STEP LOI = 50 (1975-90) | 26.9 | 40.3 | 10.2 |
| STEP LOI = 75 (1975-90) | 27.2 | 43.3 | 10.2 |

Table 3. Tests of the Effects of Different Levels of Forced Innovation (LOI).

The Transitional Community

Another phenomenon which has occurred in many locations in the United States has been that of the transitional community. Such communities have been observed in urban, suburban, and rural settings. Transition has occurred with the aging of communities, especially in the inner circles of metropolitan regions. It has also occurred in inner-cities during periods of major renovation. The former dynamic typically involves the replacement of upper- and middle-class populations by less affluent groups. The latter signals the economic reassertion of the affluent as they displace the poor. Similar transitions have taken place as urban populations have relocated to the suburbs, most of which were at least marginally rural, and to the exurbs. In the latter case, truly rural communities have at times come to be marked by competition for control over schools and other political institutions between traditional populations and newcomers with significantly different expectations, especially for schools.

Transitional communities have often been buffeted by intense and sustained

conflict between groups with substantially different norms. Schools have often been particular targets for such conflict. It is interesting to note that the model, consistent with observed experience, produces the most intense conflict under conditions of changing community norms (see Table 4).

| | | CONFLICT | |
|---|---|---|---|
| POLICY VARIABLE(S) | LOI (FINAL VALUE) | HIGH | END |
| CN=50 | 42.5 | 78.3 | 34.7 |
| CN=50<br>LN=50 | 43.0 | 78.8 | 34.1 |
| CN=50<br>LN=50<br>STEP LE = 25 | 49.1 | 54.6 | 39.5 |
| CN=50<br>STEP LE = 25 | 48.8 | 54.1 | 39.8 |

Table 4. Tests of the Effects of Changing Leader Norms (LN) and Leadership Effectiveness (LE) in Conjunction with Changing Community Norms (CN).

The reason for this is that in the transitional community all sources of conflict are deeply tapped. There is conflict not only from the rate of innovation and from discrepancies between the level of innovation and prevailing norms--as there is in the case of externally mandated reform--but there is also intense conflict generated from the discrepancies in values among the various constituencies, themselves. In the case of the external mandate, the teachers, taxpayers, and school leadership may not disagree so much among themselves as with the direction of the external mandate. In the case of the changing community, however, it is the political conflict among these major constituencies which helps to raise overall levels of conflict to extremely high levels.

With this in mind, two additional policy tests were carried out. Essentially, the purpose of these tests was to examine the role of leadership under conditions of changing community norms. Two questions were posed: (1) What difference in the behavior of the system would occur if leader norms shifted exogenously along with community norms, and (2) What difference in the behavior of the system would occur, with and without exogenous shifts in leader norms, from improved leadership effectiveness? The results of these tests are also displayed in Table 4.

Perhaps surprisingly, exogenous changes in leader norms make almost no difference whatsoever in the behavior of the system. The patterns of conflict and innovation are just about identical between the two conditions. This occurs because, for reasons previously noted, leader norms shift rapidly with community norms, anyway. (Not necessarily, of course with the norms of particular political minorities but predictably with the norms of the political majority.) Thus, the structure of the system pressures changes in leader norms without "normative reeducative" strategies.

However, it is also interesting to see the difference which leadership effectiveness makes in the patterns of both conflict and innovation. With exogenous pressure to improve leadership effectiveness (representative of better recruitment, selection, and training in the real world), there is a substantial increase in the final level of innovation toward parity with new community norms (which in the test case have been gradually increased from an initial value of twenty-five to a new value of fifty). [Again, see Table 4.] Furthermore, this change in substantive results is accompanied by still high but significantly lower levels of conflict. Before the change in leadership effectiveness, conflict reached a scale value of just under eighty; with the improvement in leadership effectiveness, the highest conflict levels reached approximately fifty-five (Table 4).

## Discussion

The results of a study must be understood in terms of its purposes. The concern which initially gave rise to the work focused upon the fragmentary state of the existing body of research on educational change. Research has been done almost exclusively on the adoption and implementation of discrete innovations within time periods ranging from months (e.g, Gross, Giacquinta and Bernstein, 1971) to a few years (e.g., Wolcott, 1977). Longitudinal studies over long periods of time are rare (Weiser, 1976, is an example of an historical study which employed both original and retrospective sources to examine phenomena over a ten year time period). No studies have been found which recorded and investigated innovativeness in school districts over periods of twenty years or more.

Cross-sectional studies, together with the few longitudinal case studies noted, have produced knowledge about the long-term dynamics of change which, at best, is partial and merely suggestive. It has seemed important, however, to begin to synthesize within a unitary theoretical framework the social, political and technical-managerial dimensions of the innovative process. Given the emphasis in the literature on the management of change (see Gaynor, 1981), it seemed especially important (1) to place leadership effectiveness in a broader context and (2) to make as explicit as possible the ways in which it is connected to other elements in this broader system, Given the author's commitment to leadership training, it has been encouraging, although frankly unexpected (cf., Gaynor, 1981), to find that leadership effectiveness does, indeed, seem to play a central role in the process of innovation.

It has seemed particularly important to make explicit the functional connections which ultimately define the domain of leadership and the meaning of leadership effectiveness. It is implied structurally in the model that leadership effectiveness is defined in terms of (1) the technical management of planning and implementation, (2) creating structures and supervising others

in a way which reduces conflict, (3) maintaining the kinds of supervisory and interpersonal relationships which allow leaders to influence others, both professional personnel and taxpayers, and (4) developing and maintaining the technical and educational knowledge base to connect well with a variety of sources of technical and fiscal resources. To be able to visualize a conceptual framework within which these skills are demonstrably important is to provide a theoretical basis for training and research.

Clearly, it is most desirable to produce theoretical models whose parameters have a high degree of accuracy. This is certainly not the case with the present model. The state of knowledge in the field simply does not speak precisely enough to relationships among the variables. What is available from the research to date is a sense of what are the major variables which interact with and impact on innovation. Field work has also provided some idea of the major adjustment times involved, especially with respect to conflict generation and political action involving administrators, teachers and citizen groups (Herriott and Gross, 1979; Weiser, 1976; Wolcott, 1977).

The focus of the Public School Change Model has been to synthesize key variables theoretically, and to make some preliminary and tentative statements about the relative importance of different system elements. Findings suggests the importance of doing research over long time frames which is focused on the processes of innovation. Such research should seek to determine more clearly the nature of particular relationships (e.g., between conflict and implementation/discontinuation). This seems particularly crucial to the formulation of more accurately parametized theoretical models.

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