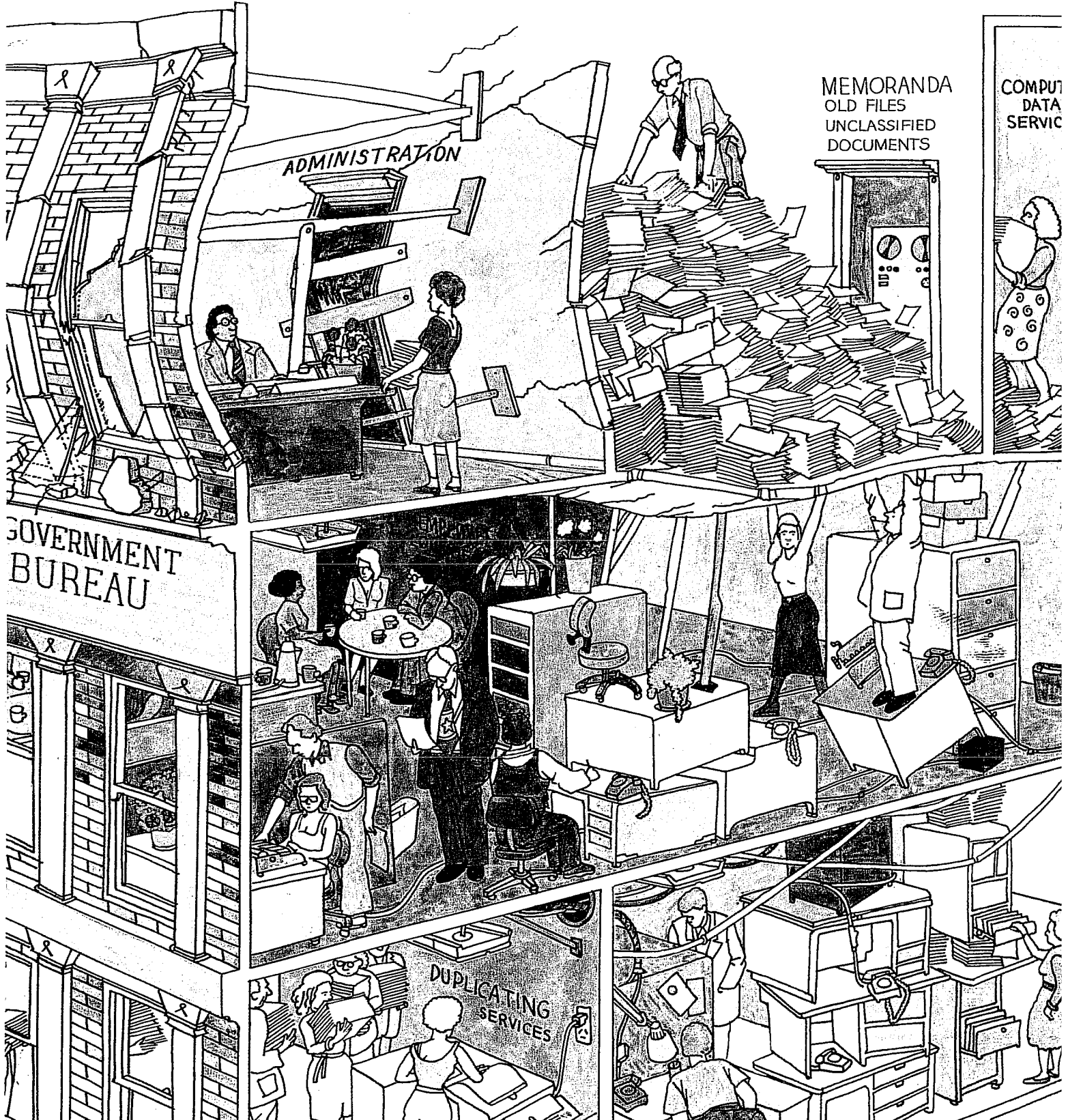


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## The Limits to Complexity: Are Bureaucracies Becoming Unmanageable?



# The Limits to Complexity: Are Bureaucracies Becoming Unmanageable?

by Duane S. Elgin and Robert A. Bushnell

Social systems tend to decline in performance as they become bigger, more complex, and increasingly incomprehensible. They also become less amenable to democratic control, and more vulnerable to disruption at key points. There now appears to be evidence that we may be pressing against the relative limits of our ability to manage large bureaucracies.

Modern society must face up to the prospect that we may be reaching the limits of our capacity to manage exceedingly large and complex bureaucracies. Already there is considerable agreement regarding the details of bureaucratic malfunction, such as massive but ineffective urban governments and huge but wasteful governmental programs. Indeed, there is growing concern whether many of the largest bureaucracies can survive.

Consider a sampling of recent statements by opinion leaders:

Ten years ago government was widely viewed as an instrument to solve problems; today government itself is widely viewed as the problem.

Charles Schultze and Henry Owen,  
*Setting National Priorities*, 1976

We're frantically trying to keep our noses above water, racing from one problem to the next.

U.S. Senator Adlai Stevenson,  
*U.S. News and World Report*,  
November 10, 1975

The demands on democratic government grow while the capacity of democratic government stagnates. This, it would appear, is the central dilemma of the governability of democracy which has manifested itself in Europe, North America, and Japan in the 1970s.

*Report to the Trilateral Commission on the Governability of Democracies*, 1975

These statements raise the possibility that, with an enormous increase in our technological capacity, we have rushed to create bureaucracies of such extreme levels of scale, complexity, and interdependence that they now begin to exceed our capacity to comprehend and manage them. We are discovering that the

power to create large, complex social bureaucracies does not automatically confer the ability to control them.

Recognition of the growing complexity of social systems as a problem worthy of attention in its own right emerged during a recent study, conducted by the Center for the Study of Social Policy, a division of SRI, Inc., in Menlo Park, California, which was seeking to identify important future problems that now are receiving insufficient attention.

## Problems of Large, Complex Systems

After an extensive review of literature pertaining to the problems of bureaucracies, 16 propositions were selected as a useful sample of the problems associated with the growth of social systems. (See list.)

These propositions are not necessarily problems per se, but they become problematical in accordance to the relative *speed* of systems growth, its relative *size* (the absolute number of elements grouped together), its *complexity* (the number and diversity of elements in the system), and *interdependence* (tightness

of coupling among elements both within and between bureaucracies). Thus, although the size of a social system is not the exclusive consideration in formulating these propositions, it is the primary point of reference from which the patterns of growth of large, complex systems are explored.

This article focuses on problems of large social bureaucracies as exemplified by the welfare system, the Medicare-Medicaid programs, and major metropolitan governments. These bureaucracies are very large and complex, highly interdependent, and concerned primarily with the delivery and consumption of public services. They are further characterized by high levels of human interaction and by ambiguous and sometimes conflicting objectives.

Although this article is directed principally to the problems of bureaucracies in the public sector, it also has relevance for private sector bureaucracies (such as large corporations). Crucial differences between these two categories of bureaucracies, however, prevent the direct application of this discussion to private sector bureaucracies.

## Problems of Large, Complex Systems Summary

It is hypothesized that if a social system grows to extreme levels of scale, complexity, and interdependence, the following characteristics will *tend* to become manifest:

1. Diminishing relative capacity of a given individual to comprehend the overall system.
2. Diminishing level of public participation in decision-making.
3. Declining public access to decision-makers.
4. Growing participation of experts in decision-making.
5. Disproportionate growth in costs of coordination and control.
6. Increasingly de-humanized interactions between people and the system.
7. Increasing levels of alienation.

8. Increasing challenges to basic value premises.

9. Increasing levels of unexpected and counterintuitive consequences of policy action.

10. Increasing system rigidity.

11. Increasing number and uncertainty of disturbing events.

12. Narrowing span of diversity of innovation.

13. Declining legitimacy of leadership.

14. Increasing system vulnerability.

15. Declining overall performance of the system.

16. Growing deterioration of the overall system unlikely to be perceived by most participants in that system.

The 16 problems are as follows: (Note: Each problem should be read as if it began with "When a bureaucracy grows to extreme levels of scale, complexity, and interdependence, then . . .")

1. **The relative ability of any individual to comprehend the system will tend to diminish.**

This proposition applies both to the public that is served by the social system and to the decision-makers who run it. To manage a social system effectively, a decision-maker must acquire knowledge at a rate at least equal to the pace at which decisions become more numerous and complex.

As a system grows in scale, the parts of the system will increase generally in an arithmetic progression but the interrelationships between the parts will tend to increase in a geometric progression. Hence, the *knowledge required* to comprehend both the discrete parts and their interrelationships will tend to increase geometrically, but due to the decision-maker's biological, mechanical, and temporal limitations, the *knowledge available* is likely to grow relatively slowly.

The importance of this problem is stated succinctly by seasoned bureaucrat Elliot Richardson in his book, *The*

*Creative Balance* (New York: Holt, Rinehart, & Winston, 1976):

For a free society, the ultimate challenge of the foreseeable future will consist not simply in managing complexity but in keeping it within the bounds of understanding by the society's citizens and their representatives in government.

Thus the size and complexity of social systems may jeopardize representative democracy itself. There is evidence to suggest that the relative levels of the public's comprehension of social systems may be declining significantly. For example, over a number of years, the Survey Research Center in the University of Michigan has asked people if they agreed or disagreed with the following statement: "Sometimes politics and government seem so complicated that a person like me can't really understand what's going on." In 1960, 40% of those responding disagreed with this statement and in 1974 only 26% disagreed.

The fact is that the stuff of public life seems to elude the grasp of many people. Bureaucratic processes have become specialized and professionalized. Yet, many of the larger bureaucracies are plagued with the unspoken but undeniable feeling among management and staff that no one truly is in control, that the dynamics of the organization are beyond the comprehension of any one individual.

Nor does the mere aggregation of information necessarily contribute to the understanding of the system. Although the computer revolution has vastly increased the amount of information at our disposal, it has exacerbated the difficulty of decision-making by confronting the manager with a mountain of information that he has no hope of ever assimilating given the crisis management that prevails in many of the largest bureaucracies. Thus, the ability to collect massive amounts of information does not automatically assure that it will be used or be useful in the management of large systems. It is possible to be information-rich and knowledge-poor as a manager or consumer of public services.

2. **The capacity and motivation of the public to participate in decision-making processes will tend to diminish.**

As discussed in Proposition 1, the relative capacity of all constituents of a social bureaucracy to participate knowledgeably in decision-making may diminish as the system grows. At larger scales, the perceived significance of an individual's participation in systems governance, especially through the act of voting, is impaired by the participation of large numbers of people in the process.

At smaller scales there is much greater opportunity for an individual citizen to have a discernible impact, but these

## The "Ratchet Effect": Reasons Why Bureaucracies Grow Too Large

- **Imprecise means of measurement.** The "rule of profit" may be harsh, but for business firms it is a relatively certain yardstick against which to measure the efficiency of a given scale of activity. In contrast, governmental bureaucracies and other social systems must attempt to measure efficiency via a number of qualitative, multidimensional, often conflicting, and ambiguous measures and objectives. With virtually no measures of system health, bureaucracies can conceivably grow to excessive scales of social organization.

- **Responding to the needs of a given population.** A business firm can choose its scale of operation so as to maximize efficiency. However, many government bureaucracies are obliged by law and/or by egalitarian principles to attempt to respond to the needs of an entire population or population segment (e.g., all old people, all school-age children, all poor people who are in ill health). There may be little choice as to the size of the bureaucracy if it is largely dictated by the size of system needed to respond to a given population segment.

- **Bureaucratic imperative.** If the size of a system or subsystem is considered an important source of status and power to the managers of that system, then systems managers may attempt to foster the growth of a system in order to secure greater benefit for themselves—even at the cost of a decline in overall systems efficiency. This "tragedy of the commons" behavior within a bureaucracy may be prompted by the search for a larger staff, a larger budget, greater respon-

sibility, and so on. If many bureaucrats pursue this behavior, the collective effect could be considerable in producing an inefficient scale of activity in social bureaucracies.

- **Technological imperative.** Technology provides the possibility to vastly expand the scale of social systems, and this possibility often seems to be translated into a necessity. Social systems may be designed so as to reap the maximum benefits from potent technologies (ranging from computers to photocopying machines) only to find that the overall system (which includes the human element) now exceeds its most efficient scale. Thus, uncritical adoption of technologies may push a system to excessive scales of social organization.

- **Growth is good.** A central value premise in the industrial world view has been that growth is good. This has created a climate in which a concern for the bigness of our social bureaucracies would be less likely to be questioned.

- **Something for everyone.** Political bureaucracies employ the art of compromise in an attempt to provide "something for everyone" so that no important constituency will be alienated or angered. The bureaucracy defends its own interest group and draws support from the many persons who depend on its continued existence. Intrinsic to democratic political processes, then, is a pattern of expectations and demands which tends to inhibit the reduction of bureaucratic activity which, once instituted, becomes the norm.



Looters take advantage of New York City's massive blackout in July 1977. The failure of the complex electric power supply system led to this scene at a Bronx supermarket. Woman extends helping hand to elderly man clutching a single box of crackers; better equipped youth carries off his booty in knapsack and tote bag. Authorities arrested thousands of looters in New York during the blackout looting.

Photo: UPI

small-scale decisions are likely to be relatively inconsequential. Robert Dahl, in an article on "The City in the Future of Democracy," concludes:

Thus for most citizens, participation in very large units becomes minimal and in very small units it becomes trivial.

To the extent that the cost (in time or money) of informing oneself for participation in the system is substantial and the perceived return from that information is trivial, then a rational response is to remain ignorant and passive. In his book, *Inside Bureaucracy*, urbanist Anthony Downs explains:

Therefore, we reach the startling conclusion that it is irrational for most citizens to acquire political information for the purposes of voting. . . . Hence, ignorance of politics is not a result of unpatriotic apathy; rather it is a highly rational response to the facts of political life in a large democracy.

### About the Authors

Duane S. Elgin is a consultant to the Center for the Study of Social Policy at SRI, Inc., in Menlo Park, California, and is currently setting up a Center for Transformational Studies. His address is P.O. Box 2483, Menlo Park, California 94025. See his article on "Voluntary Simplicity: Life-Style of the Future" in the August 1977 issue of THE FUTURIST.

Robert A. Bushnell is an attorney in private practice in Boise, Idaho, and was formerly General Counsel for the Idaho Department of Health and Welfare.

An initially diminished capacity to participate as a result of mounting complexity is thus coupled with incentives that further reinforce the diminished capacity. As part of a self-fulfilling pattern, the power and willingness to make decisions are shifted from the public to the systems managers.

### 3. The public's access to decision-makers will tend to decline.

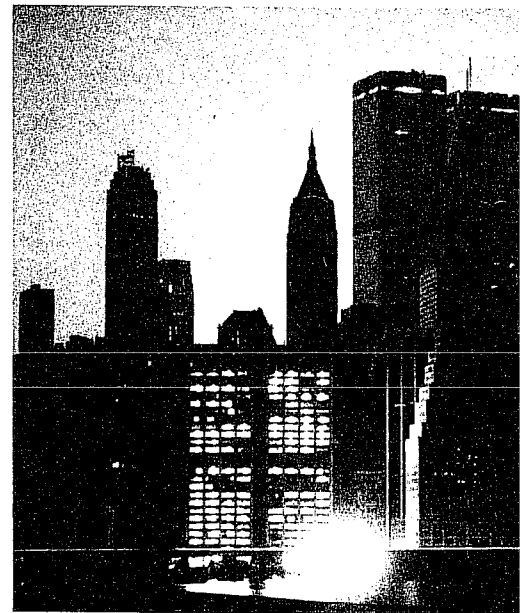
Regardless of the size of his constituency, there is only one mayor, one governor, one Secretary of Health, Education and Welfare, and one President. As the number of persons under his jurisdiction grows, an inevitable consequence is a reduction in the amount of time that a manager can spend with any one person. Beyond some threshold size, general access to the leader will, for all practical purposes, be eliminated.

In his discussion of the effects of scale upon a political system, Robert Dahl states:

The essential point is that nothing can overcome the dismal fact that as the number of citizens increases the proportion who can participate *directly* in discussions with their top leaders must necessarily grow smaller and smaller.

Certainly the actual degree of public access to its leaders has steadily declined as the scale of institutions has increased.

Despite this gradual erosion of access, the perception of this process by the public seems relatively recent. A 1975 Louis Harris survey reveals substantial



Blackout of New York City demonstrates how a breakdown in one part of a complex system can have enormous and widespread impacts. This photograph shows the New York skyline on July 13, 1977, during the second major blackout of the city.

Photo: UPI

changes in citizen perceptions of distance from their leadership during the period of 1966 to 1975. Although this period included the unusual events surrounding Watergate and the Viet Nam War (which exacerbated the feeling of distance between the American people and their leaders), the statistics, nonetheless, are striking.

The feeling that "What I think doesn't really count much any more" has risen from 37% to 67% since 1966; the view of the "People with

power are out to take advantage of me" has jumped from 33% to 58% over the same period; the notion that "People running the country really don't care what happens to me" has gone up from 33% to 63%.

As our bureaucracies burgeon, they recede from the comprehension, the familiarity, and the control of the public.

**4. Participation of experts in decision-making will tend to grow disproportionately, but this expertise will only marginally counteract the effects of geometrically mounting knowledge requirements for effective management of the bureaucracy.**

It seems reasonable for a decision-maker faced with a large number of complex problems to seek expert advice in trying to grapple with those problems. Yet, as Elliot Richardson has warned in *The Creative Balance*, this apparently rational response to complexity may reduce the ability of the public to participate in decision-making:

Unless we in America can succeed in [managing complexity] . . . we shall lose our power to make intelligent—or at least deliberate—choices. We shall no longer be self-governing. We shall instead be forced to surrender more and more of our constitutional birthright—the office of citizenship—to an expert elite. We may hope it is a benevolent elite. But even if it is not, we shall be dependent on it anyway. Rather than participating in the process of choice, we shall be accepting the choices made for us.

Moreover, it is possible that exponentially growing needs for knowledge in decision-making will eventually overwhelm the expert as well as the decision-maker. The expert ultimately faces the

**5. The costs of coordinating and controlling the system will tend to grow disproportionately.**

Initial increases in scale allow greater efficiency by facilitating specialization and division of labor and by allowing the use of more advanced technologies (which may only become cost-effective for larger organizations). Yet, at some scale of activity, the number of units in the system will grow so large that the costs of coordinating and controlling those units will more than offset any increases in efficiency that accrue from the larger scale.

As the bureaucracy grows and top management becomes increasingly divorced from day-to-day functioning of the system, decision-making responsibility and authority must be delegated to successively lower levels within the system. This, however, requires increases in staff, paper work, travel budgets, and communication costs if the plans and decisions of a vast number of separate decision-making units are going to mesh. Beyond some critical threshold of size, then, the costs of coordination grow disproportionately.

**6. An attempt may be made to improve efficiency by depersonalizing the system.**

Since human diversity adds enormously to a system's complexity, a potential means of coping with complexity is to reduce the diversity of human interactions within the system. Rational management techniques may attempt to depersonalize the system by standardizing human responses within the organization.

To the extent that efficiency is valued over human diversity, the human inter-

action with the system must acquire attributes that increasingly conform to the systemic preference for uniformity and predictability. Employees, constituents, or clients will tend thus to become increasingly depersonalized in their interactions with the system.

from 9% to 41%. These and related data suggest that the level of public alienation may be reaching pathological proportions.

Nor is the sense of alienation limited to a particular segment of society. In a 1976 *Saturday Review* article, Leonard Silk and David Vogel examined the crisis of confidence in American business and concluded that it is a part of a larger pattern of alienation:

The mood for business leadership is strikingly similar to that of other groups in one important respect: a feeling of impotence, a belief that its future is in the hands of outside forces. For business, as for other groups, frustration often turns to hostility. Feelings of alienation that began in the black community soon spread to the children of the middle class, moved into the white working class, and have affected the military and the police. This mood has now reached the business community. . . . It is a remarkable society in which so many groups, even the "Establishment," feel that "someone else" is in charge, "someone else" is to blame for whatever goes wrong.

Sociologist Melvin Seeman postulates five historical trends that may form the causal basis for the emergence of alienation. These are directly or indirectly tied to the emergence of very large social systems:

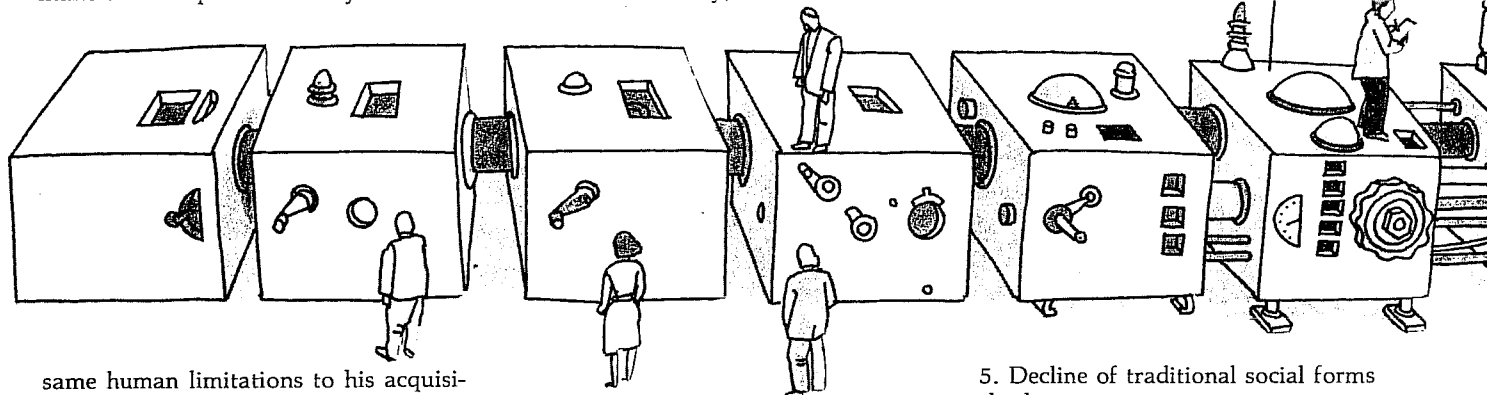
1. The expansion of scale of population and social institutions.
2. The decline of kinship and the consequential increase of anonymity and impersonality in social relations.
3. Increased physical and social mobility.
4. Social differentiation arising from specialization and division of labor.

5. Decline of traditional social forms and roles.

These observations suggest a rather direct linkage between alienation and the growth of large social systems.

**8. The appropriateness of basic value premises underlying the social system will tend to be increasingly challenged.**

This proposition assumes that as a system grows, the sheer quantitative aggregation will ultimately result in the emergence of a qualitatively different system. Thus, the value premises upon which the system was initially established will become increasingly incom-



same human limitations to his acquisition of knowledge as does the decision-maker and the general public.

Further, there appear to be intrinsic limits to the assistance that experts can render to decision-makers. Expert knowledge may be so fragmented, as a result of specialization, that it is below the necessary threshold of aggregation to be useful to the decision-maker. Also, the information may be exceedingly complex and difficult to transmit efficiently from expert to decision-maker. Accordingly, expert information may be ignored for very rational reasons.

**7. The level of alienation will tend to increase.**

A 1975 Louis Harris survey reveals that in the period from 1966 to 1975, the number of people who say "I feel left out of things going on around me" has risen



patible with the changing demands of a quantitatively enlarged and qualitatively altered system.

To the extent that large, complex social systems have been created by value premises that have become functionally obsolete, then either the system must change to reflect the original values, or the basic value premises themselves will have to change to reflect the character of the changed system. Social conflict will increase until either the value premises or the system itself is changed so as to reestablish congruence between them.

Contemporary challenges to the legitimacy of traditional value premises have assumed such forms as women's liberation, black power, third world ethics, the antiwar movement, the hippy counterculture, the flourishing of Eastern religions, and the conservation and ecology movement. These disparate trends do not individually signify the transformation of historic value premises. Yet, considered collectively, they suggest that major challenges to traditional values are occurring.

**9. The number and significance of unexpected consequences of policy actions will increase.**

As a system grows, it may be subject to the "law of requisite variety" as stated by W. Ross Ashby in *An Introduction to Cybernetics*. This law asserts that the complexity of any policy solution must, in the long run, be equal to the complexity or variety of the prob-

lem. To the extent that diminished levels of systems comprehension (Proposition 1) force managers to apply relatively simple solutions to increasingly complex problems, then the law of requisite variety will not be satisfied and unexpected consequences of policy action may result.

Professor Jay Forrester of the Massachusetts Institute of Technology has suggested another reason why the behavior of large systems may result in outcomes that run counter to expectations. In social systems, political pressures often favor short-term policy measures, but when short-term actions, which previously produced favorable results, are redoubled without regard for their long-term consequences, changed circumstances within and without the system may produce both unexpected and even disastrous results.

With smaller and less interdependent bureaucracies, a wrong decision has only limited consequences because of the small scale and loose coupling between social systems. With very large and highly interdependent systems, however, a wrong decision can have far-reaching implications as its impact affects a pervasive and tightly interconnected web of socio-economic systems. Therefore, the number of unexpected outcomes of policy actions and the dis-

ruptive potential of these unexpected outcomes may be expected to expand as social systems grow in scale.

**10. The system will tend to become more rigid since the form that it assumes inhibits the emergence of new forms.**

Economist Kenneth Boulding has written, "Growth creates form, but form limits growth." This principle suggests that as a system grows in size, complexity and interdependence, it will seek an enduring, predictable form that will, in turn, limit the ability of the system to generate new forms. Large bureaucracies seem to exhibit this characteristic. Richard Goodwin, writing in *The New Yorker*, describes the resistance of large social systems to fundamental structural changes:

[T]he passion for size, reach, and growth is the soul of all bureaucracy. Within government, the fiercest battles are waged not over principles and ideas but over jurisdiction—control of old and new programs. Radically new pronouncements and policies are often digested with equanimity, but at the slightest hint of a threat to the existing structure, . . . the entire bureaucratic mechanism mobilizes for defense. Almost invariably, the threat is defeated or simply dissolves in fatigue, confusion, and the inevitable diversion of executive energies.

As growing bureaucracies lock themselves into relatively static and inflexible



forms, creative management becomes an exercise analogous to swimming through progressively hardening concrete and the flow of social and organizational evolution is impeded.

11. The number and intensity of perturbations to the system will tend to increase disproportionately.

As a social system grows, the number of elements aggregated together also grows. As Donald Michael notes in his book, *The Unprepared Society*, if the same proportion of those elements malfunction, then the increase in absolute numbers aggregated together should yield a greater number of disturbing events within the system.

Further, as the number and diversity of activities within a system increase and relationships among the activities are established, the number of interconnections within the system will tend to increase geometrically. If a significant proportion of those connections are vulnerable to disruption, then the number of perturbations could increase more rapidly than increases in scale.

12. The diversity of innovation will tend to decline.

As a system grows, the span of diversity of innovation will tend to constrict, because innovation is confined within the narrowing boundaries of what the system can assimilate without itself undergoing fundamental change. Further, as the system acts to ensure its own survival, diversity of innovation may become confused with disorder.

Moreover, it seems plausible that as social forms become increasingly concretized, greater reliance will be placed on technological rather than social innovation to cope with social problems. Consequently, both the breadth and the depth of innovation will tend to decline.

13. The legitimacy of leadership will tend to decline.

To the extent that a system manager must draw his power to govern from the consent of the people, then, within limits, he must demonstrate to his constituency his ability to manage the system well. As the system grows in scale and complexity, relative levels of comprehension at all levels may decline, counterexpected and unexpected consequences may mount, system resilience may diminish, and, for other reasons, the performance of the system may decline. The public will hold the manager of the system responsible for the poor performance. Then, according to the rules of the game, other leaders who wish to be elected will endeavor to persuade the public that they have the "right" and "true" answers to solve the mounting problems of systems malfunction. Thus, a doubly dangerous situation is created: there is the appearance of understanding (in order to get elected or to retain power), but the reality of understanding may be diminishing. Public expectations for effective decision-making may be inordinately high at the same time that the relative capacity to make informed decisions declines. As the gap between expectation and reality grows more pronounced, the legitimacy of the decision-maker will diminish.

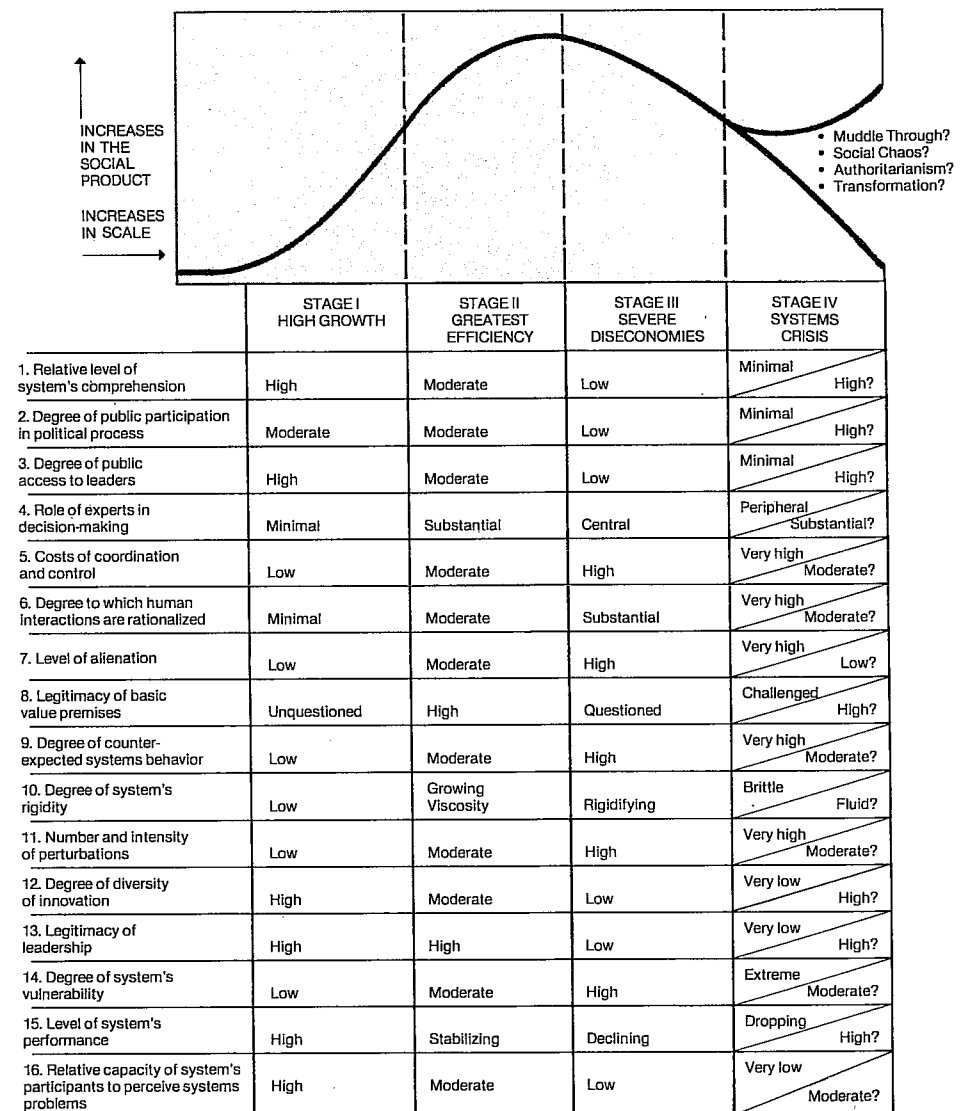
One of the most pervasive themes to be found in an examination of the

state of health of our sociopolitical systems is the crisis of confidence in leadership and the withdrawal of legitimacy. Pollster Louis Harris described the situation this way in a 1975 talk:

The toll on confidence in the leadership of institutions has been enormous, both in the public and private sectors. . . . But perhaps the most serious drops have taken place in the case of two of our most central points of power: American business and the

## Problems of Large Systems Arrayed by Stages of Growth of Bureaucracies

This graph and table sum up the authors' theory of bureaucratic development.



Large complex systems tend to decline in performance after they reach a certain size. Eventually they enter a stage of "systems crisis," which may lead to very different results: On the one hand, the systems may move toward total collapse; on the other, the systems may be transformed. The far right column suggests the shift in the character of a system if it is to successfully resolve the problems of Stage IV.

Note: The "social product" of a bureaucracy may be defined as the improvement in well-being of the clients of a system produced by the operation of that system. The social product might be health care, education, or some other public service.

## Four Stages of Growth of Bureaucracies:

Duane Elgin and his fellow researchers developed the following composite description of the behavior of a hypothetical bureaucracy as it proceeds through each of the four stages of growth.

### Stage I: High Growth/Era of Faith

In the "springtime" of growth, the relative level of systems comprehension is high, and the scale, complexity, and interdependence of the bureaucracies are low. There is a strong faith in the efficacy of shared values and goals. There is a belief that these values are part of the natural order, and that basic to this system's destiny is the natural unfolding (e.g., as if by an "invisible hand") of these values. This is also a period of great vitality, innovation, and energy as economic and sociopolitical entrepreneurs are the agents of creative expression of this social order. The social leaders have considerable legitimacy, and the high performance of the system speaks of unbounded potentials.

### Stage II: Greatest Efficiency/Era of Reason

In the "summertime" of growth, the relative level of systems comprehension is moderate, and the scale, complexity, and interdependence of the bureaucracies have increased substantially relative to the earlier period. The systems have become sufficiently complicated that their effective functioning is not simply a matter of faith but requires the efforts of a brain trust. Creative, intellectual advisors bring rationality and order into the operations of the systems and become an integral aspect of leadership.

The level of alienation increases, but this seemingly reflects a consequence of higher geographic and occupational mobility. Rather than a pathological condition, this era seems healthy in comparison to the parochialism of the preceding era. The level of systems performance is still increasing, but the bursts of vitality of Stage I have been replaced by a more methodical planning and implementation process. The costs of coordination and control are beginning to mount but can be kept within tolerable limits by the judicious use of rules and regulations to rationalize, standardize, and simplify operations.

### Stage III: Severe Diseconomies/Era of Skepticism

In the "autumn" of growth, the relative level of systems comprehension is low and dropping rapidly as large, barely comprehensible bureaucracies have grown into largely incomprehensible supersystems. As leaders disavow their responsibility for error and maximize the visibility of their own increasingly modest achievements, the system's constituency becomes increasingly disillusioned, apathetic, and cynical. Both faith in the basic soundness of the system and trust in rationality to solve the mounting problems are virtually exhausted.

Leaders are more tolerated than given active support and legitimacy—there seems little alternative than to cynically acquiesce to those leaders who say that they alone have adequate information to truly

understand what is happening. Yet, the declining levels of systems performance, the crisis atmosphere that pervades the management of the system, the growing numbers of disturbing events and the loss of allegiance to basic values create a situation in which consensus falls to very low levels. Decision-makers are increasingly unable to cope with complex problems that demand superhuman abilities. Costs and problems of coordination and control are mounting rapidly, and the benefit to the constituency seems to be declining with equal rapidity; consequently, people are less willing to support the actions of the bureaucracy.

The bureaucracy is becoming increasingly rigid, distant, and dysfunctional and yet insists that its constituency conform to its increasingly rationalized and standardized procedures when interacting with the system—thereby reinforcing the apparent inhumanity of the system and further reducing the system's legitimacy. Further, the rigidity of the system engenders a loss of resilience and, coupled with growing perturbations (many of which arise from the counter-intuitive and unexpected consequences of ill-considered policy actions), the system seems increasingly vulnerable to disruption.

### Stage IV: Systems Crisis/Era of Despair, then . . . ?

In the "winter" of growth, the relative level of systems comprehension is minimal. The systems are on the verge of chaos and collapse. There is a rapid turnover of leaders, prevailing ideology, and policy solutions—yet nothing seems to work. Every attempt at creating order (short of a highly authoritarian structure) seems overwhelmed by growing levels of disorder. The level of systems cohesion is very low which, in turn, exacerbates the problem of system's leaders who govern virtually without support.

The rigidified bureaucracy is made somewhat more resilient by the rapid turnover of personnel and policy, but the vulnerability of the system is so high and mounting crises are of such seriousness that whatever additional resiliency has been added to the system is quickly depleted in a grinding downward spiral into bureaucratic confusion and chaos. The situation becomes simply intolerable and untenable.

From this period of systems crisis, any one of four plausible outcomes may emerge: (1) successful muddling through the situation (although muddling through seems more characteristic of the processes which led to Stage IV crisis conditions); (2) a descent into chaos as the size, complexity, and interdependence of the system's problems overwhelm decision-makers; (3) an authoritarian response in an attempt to rationalize and simplify the coordination and control processes; (4) transformation as the system evolves to a higher level of structure which is both more efficient and more simple. Which of these four outcomes is most likely to occur is impossible to say without specifying the circumstances that surround a system in Stage IV crisis conditions.



federal government. High confidence in business has slipped from 55% in 1966 to 18% in 1975; in the White House it has fallen from 41% to 14%; Congress from 42% to 14%; the U.S. Supreme Court from 51% to 28%. . . . Basically, however, the startling news is that the two major institutions viewed as out of touch with the reality of what people think and want are American business, which for so long has prided itself as correctly anticipating public needs, and American political leadership, which so often has claimed to head up the most responsive democratic system in the world.

Nor is this an isolated finding. The University of Michigan Survey Research Center found that the proportion of people trusting the government in Washington to do what is right "just about always" or "most of the time" dropped from 81% in 1960 to 61% in 1970, and by 1974 the proportion had dropped to 38%. A 1975 report to the Trilateral Commission stated that "Leadership is in disrepute in democratic societies."

To the extent that the capacity to govern requires the consent of those governed, then the pervasive and sustained withdrawal of legitimacy could well cripple the capacity of democracies to manage their affairs.

#### 14. The vulnerability of the system will tend to increase.

If we assume that most of the problems of large systems move in concert or on parallel paths, then with rising scale the combined effects of the problems will render the system increasingly vulnerable to disruption. Eric Sevareid forcefully describes the vulnerability of our social systems:

We now live in and by the web of an enormously complicated, intensely interrelated technology, the whole no greater than its parts and its strongest parts at the mercy of its weakest links. This is a way of life that depends absolutely on order and continuity and predictability. But it happens that we have simultaneously reached a point of discontinuity in the political and social relations of men, where little is predictable and disorder spreads.

One hijacker can capture a multimillion dollar airplane and catapult nations into political confrontation. One defective capacitor can prevent the communication of two presidential candidates with more than 100 million constituents. The shutdown of a single brake plant can stop production at major auto assembly plants throughout the country. A localized power grid failure can plunge the entire eastern seaboard of the U.S. into darkness. The consequences of otherwise isolated and relatively insignificant events, therefore, jeopardize the continued functioning of large systems sensitive to the slightest disruption.

15. The performance of the bureaucracy will tend to decline.

If we assume that the previously stated propositions are valid, then as a social system grows to extremes of scale we would expect that the costs of coordination and control will escalate, the comprehensibility of the system will decline, the number and intensity of perturbations will increase, and so on. When these individual problems reach a critical threshold and thereby collectively and intensively reinforce each other, the decline of system performance will be accelerated.

There is no lack of opinion that the performance of many of our largest bureaucracies is rapidly deteriorating. This is graphically reflected in a statement by U.S. Representative James C. Cleveland:

There is no question that the American people are coming to the conclusion that their Government couldn't run a two-car funeral without fouling up the arrangements.

16. The full extent of declining performance of the system is not likely to be perceived.

In most large bureaucracies there are few reliable measures of systems performance. This is partially attributable to the fact that the complexity of the system obscures the operation of the system. Also, the bureaucrat, in order to acquire or retain power, may minimize the significance of malfunctions and error, and maximize the public visibility of his own achievements. Further, there may be delayed, ambiguous and conflicting feedback concerning the effectiveness of various programs. These and other forces make it difficult to monitor the performance of a massive bureaucracy and thereby make it unlikely that most persons will be able to perceive the true extent to which performance is declining.

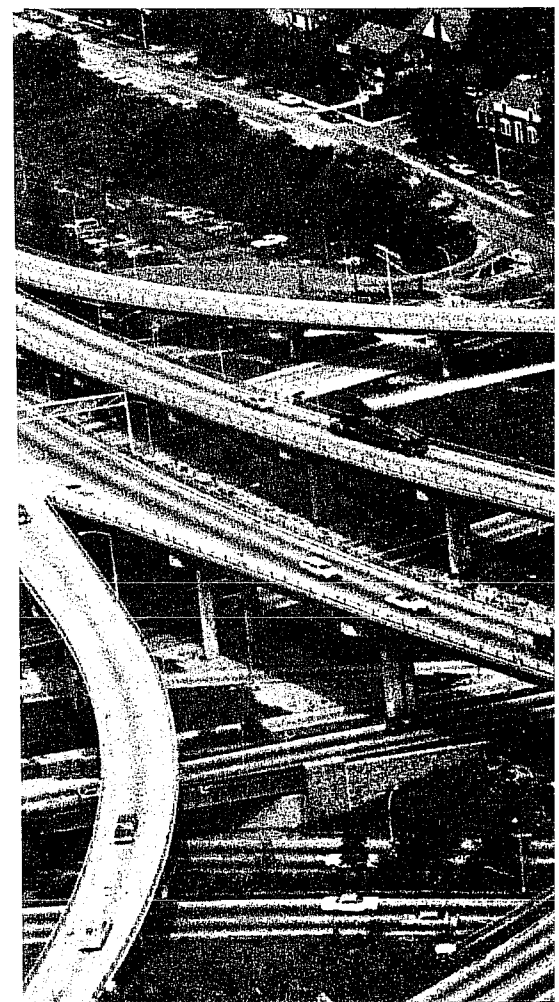
We have briefly examined a range of problems that are hypothesized to emerge as social systems grow to extremes of scale. The question naturally arises, are these problems connected with one another or do they arise independently and randomly? Since we are considering systems problems—where, by definition, everything is connected to everything else—it seems logical that we might discern a coherent pattern of interconnection among these various problems.

#### Stages of Growth of Social Systems

In order to identify and describe patterns of systems problems, we require a common frame of reference from which to search for that pattern. Fortunately, a single common denominator among these 16 propositions does exist. Each is defined so that it changes with variations in scale. This is *not* to say that the scale of a social system, per se, is critical. In many instances, complexity (or

the number and diversity of interactions among systems elements) seems a more serious contributor to many of these problems than does scale. However, scale or size does provide the Occam's Razor to cut through a maze of complexity and establish a consistent frame of reference from which to explore relationships between problems.

Before we can infer the patterns of problems that might emerge as a system grows in scale, we must first describe the nature of the basic pattern of systems growth itself. Indeed, the model or description of the nature of social systems growth that we select will strongly condition what pattern of problems will be perceived. Fortunately, there exists a widely used concept in economics that



lends itself well to clarifying our understanding of the cycle of growth that may occur as a system grows to extremes of size.

One of the few "laws" in economics is the "law of diminishing returns." One application of this law asserts that, at some size or scale of activity, no further advantages can be derived from further increases in scale; moreover, if scale continues to increase, diseconomies of scale will emerge. In other words, the system can reach a size where efficiency

fails to increase as the organization becomes larger.

The difficulty in applying the "law of diminishing returns" to the growth of bureaucracies is that economic theory assumes that the rational organization will recognize when it is growing too large (is experiencing "diseconomies of scale") and choose to halt its growth at that point. Perhaps business firms, governed by the relatively precise rule of profit, will not intrude too far or for too long into a domain of increasingly severe diseconomies of scale. However, there are a number of reasons to think that our governmental bureaucracies may grow into this region and persist there for some time. (See box giving reasons for this "ratchet effect.")

shrink in size; rather, it would tend to grow smaller only when forced by the necessities of its own survival or by the superior power of a higher-order system.

With the ratchet effect inexorably driving the growth of government bureaucracy, it becomes necessary to extend the application of the "law of diminishing returns" to include the range of severe diseconomies of scale, and beyond. By extending the domain of organizational performance considered under the "law of diminishing returns," we derived a four-stage life-cycle of the growth of social systems. (See graph). The four stages in the life-cycle of social systems growth are: an initial stage of high growth, a second stage of great ef-

describe how each of the 16 problems would likely become manifest in each of the four stages of growth (this synthesis was achieved through logical inference aided by computer simulations).

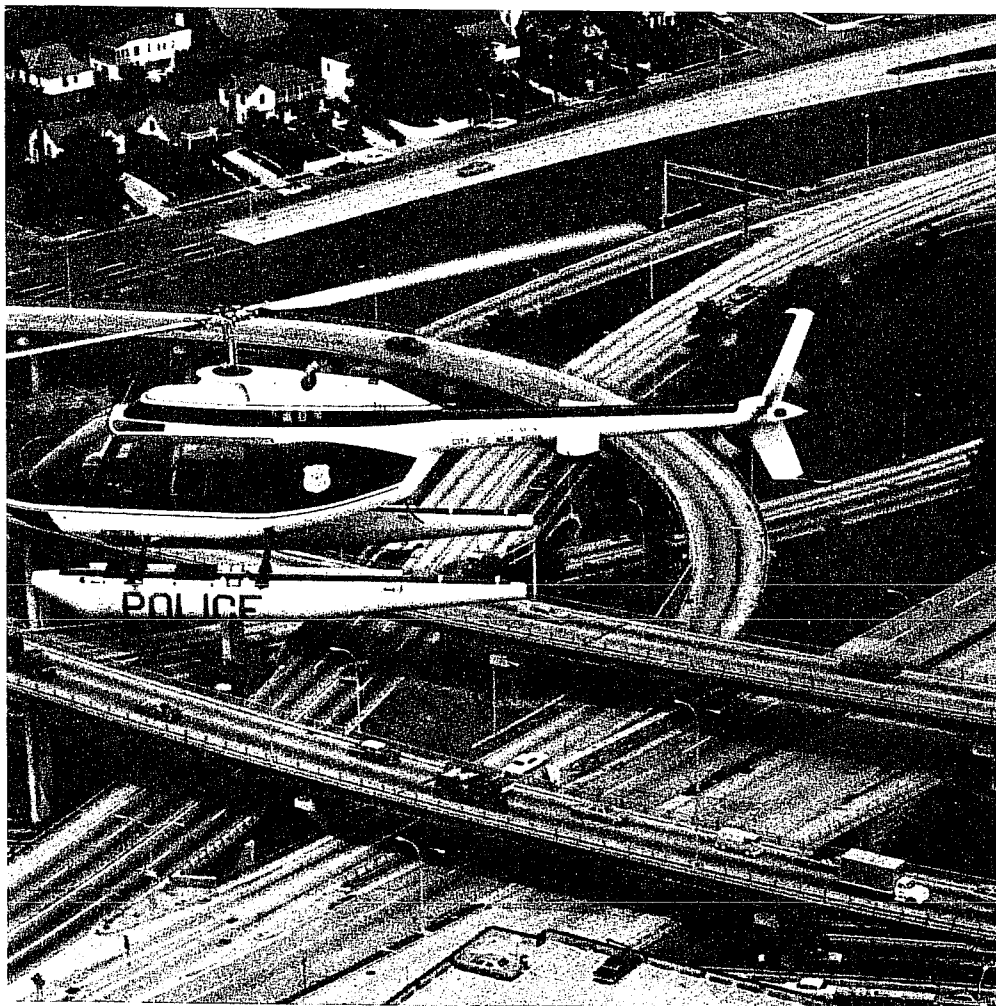
### Where Are We Now?

Given this four-stage description of the life-cycle of bureaucracies, where might present social systems be located relative to each of the four stages? Although hard evidence is scanty and dispersed, the information gathered so far suggests that a number of the largest government bureaucracies in the U.S. are experiencing severe diseconomies of scale (a Stage III condition).

A prime example of the present plight of large bureaucracies is the massive, exceedingly complex, and highly interdependent U.S. welfare system. There seems to be general agreement that the welfare bureaucracy is plagued by high costs, wasteful administration, inadequate performance, ineffective coordination and control of programs, and so on. Many of the problems of the present welfare system seem characteristic of a system either in Stage III (severe diseconomies of scale) or, as some might argue, intruding into the Stage IV region of systems crisis.

Thus, for some social systems (such as the welfare bureaucracy), the problem of reaching limits to the manageability of systems is already assuming critical proportions. And, given the built-in momentum toward ever greater scales of activity via the "ratchet effect," an increasing proportion of our major social systems seem likely to grow into Stage IV (systems crisis). The overall criticality of systems problems will depend considerably on the proportion of our larger social systems that may *simultaneously* intrude into a stage of severe systems malfunction. If many social systems enter Stage IV (systems crisis) at about the same time, there may be little resiliency or vigor in the remaining systems for those bureaucracies in difficulty to fall back upon.

In short, the problem of institutional "limits to growth" seems increasingly critical for *some* bureaucracies at the present time and, if this model has descriptive validity, then it seems likely that these "limits" will become increasingly critical for *many* bureaucracies in the decades ahead. It is our judgment that the constellation of problems characteristic of the later stages of the cycle of growth will become increasingly critical, long-term, pervasive, and difficult to solve. In turn, if this ballpark estimate of the situation is accurate, then it seems likely that long before we reach resource and environmental "limits to growth," we will reach institutional "limits to growth" imposed by the malfunctioning of our major social systems.



Tangle of superhighways reflects the fantastic complexity of modern transportation. To prevent massive traffic tie-ups, New York City's police use helicopters to spot trouble quickly.

Photo: Bell Helicopter, Fort Worth, Texas

Even if a bureaucracy were aware that its size was excessive, the "ratchet effect" could strongly inhibit retreat from that scale of activity. The notorious difficulty in eliminating or restructuring a government agency or program seems a manifestation of the ratchet effect. It seems unlikely, then, that a government bureaucracy would voluntarily

efficiency, a third stage plagued by diseconomies of scale, and a fourth stage of systems crisis.

Having developed this four-stage description of the life-cycle of social systems growth, we can now mesh the model with the 16 problems proposed as intrinsic to many large, complex social systems. A matrix format was used to

# Four Alternative Outcomes From Stage IV: Systems Crisis

**1. Muddling Through:** Muddling through or incremental policy making tends to minimize the threat of social cleavage by not challenging the fundamental premises on which policy is based. However, in a period of crisis the need to fundamentally re-examine policy premises is likely to be considerable. Although incremental muddling through a system crisis of major proportions seems unlikely, there are circumstances in which this outcome is plausible. If one assumes that the system in crisis is surrounded by other, supportive systems which are relatively healthy, then it is quite conceivable that the strength of the other systems could cushion the transitional period for the system in trouble. Nonetheless, it seems unlikely that muddling through will offer a permanent solution to coping with the kind of systemic problems discussed here.

**2. Descent into Chaos:** Another plausible outcome of Stage IV is that of chaos. System chaos emerges when old forms are demonstrably dysfunctional and new forms have not yet emerged or been sufficiently tested to provide a workable alternative. The growth into Stage IV conditions without workable alternatives could result if the dominant social systems co-opted the energy of creative persons into dysfunctional but still privately rewarding social structures. Thus, a system could intrude into Stage IV and be pushed to fundamentally respond; but if alternative systems have not developed, the demise of old structures could leave a relative vacuum.

The ensuing period of chaos could be seen as a compressed period of institutional innovation. The seeming disorder (with accompanying turnover of ideologies, persons in power, and proposed solutions) could be viewed instead as creative chaos that generates a sufficient diversity of alternative innovations to develop new systems with greater "efficiency" and "utility." In this alternative, then, disorder and chaos could provide the necessary conditions for stimulating the diversity of innovation that allows people to cope with systems crisis.

**3. Authoritarian Response:** Another plausible outcome is some form of authoritarianism. To cope with overwhelming levels of systems complexity and to create a more efficient bureaucracy, attempts could be made to drastically rationalize and simplify coordination and control processes. Democratic systems, being notorious for their complexity and ambiguity, could be a prominent victim of the necessity to create increasingly ra-

tionalized and simplified control structures. The adaptation of "authoritarian" coordination and control structures need not be rapid or readily apparent. Rather, if the period of diseconomies and crises (Stages III and IV) were protracted, the system might adapt in the long run a more authoritarian form than was intended by incremental actions in the short run.

Yet even an authoritarian outcome might be only temporary. An authoritarian social system, with its more highly rationalized and simplified coordination and control structures, probably would be able to endure for only a somewhat longer period of time than the more inherently complex democratic systems. The onslaught of complexity knows no ideological boundaries and would impinge, perhaps with nearly equal force (when it begins to mount geometrically upward), on both democratic and authoritarian systems alike. Further, the rigidity of authoritarian systems lowers their resilience and makes them much more vulnerable to extinction. Thus, authoritarian social systems would likely only delay movement into Stage IV, the Systems Crisis.

**4. Transformational Change:** The transforming process implies that the system would go beyond present forms. Since emergent forms are seldom clear, it is impossible to specify the exact nature of transformational change except to suggest that it tends generally to produce systems with: (1) a higher level of structure which can encompass and manage the enlarged system; (2) greater overall simplicity which increases the efficiency of operation; and (3) higher levels of self-reflective awareness, which allows the system to see its own functioning more clearly and thereby permits a more harmonious orchestration among all components of the system.

Perhaps to understand systems transformation, a conceptual transformation is first needed that allows people to view the process of social change differently. If systemic evolution were viewed as a dynamic process, then it might be easier to view the goal of social systems change, not as the creation of a static end state, but rather as a continuous process of human and social growth. This implies that instead of attempting to arrest the growth of a social system at a particular stage, people would endeavor to participate openly and fully in the natural and inevitable process of social systems evolution. Openness to change (and recognition of the impermanence of all social systems) may be a precondition to dynamic social stability.

In a sentence, the time available to respond creatively to increasingly severe systems problems seems very short.

### Coping with Institutional "Limits to Growth"

A number of different strategies could be applied in coping with the problems of large, complex bureaucracies.

- Develop alternative models of the behavior of bureaucracies as they evolve over time to ever greater levels of scale, complexity, and interdependence.

- Conduct surveys to ascertain the present status of key social bureaucracies whose continued vigor seems central to a healthy society. Such a survey could, for example, engage the politician and bureaucrat in the process of describing the behavioral properties and problems of large, complex social bureaucracies.

- Develop a spectrum of systems indicators—patterned after economic and social indicators—that may better inform us as to the state of "health" of our central social bureaucracies.

- Encourage the President to consider the state of the social bureaucracies when examining the state of the nation.

- Fund research on the least understood of the four hypothesized outcomes from a period of "systems crisis"—namely, what the nature and form of transformational change of major social bureaucracies could be.

- Explore new individual learning modes that could increase the rate and richness of our acquisition of knowledge (the internalization of information).

- Develop new group learning processes to enable more effective knowledge aggregation and patterning.

- Fund television programs (such as *Nova*) that are educational/informational at much higher levels and across a much broader range of topics and thereby attempt to inform the public of major issues of critical national importance—including the problem of the malfunctioning bureaucracies.

- Pursue governmental reorganization designed, where reasonable and possible, to reduce the scale, interdependence, and complexity of social systems.

The foregoing responses to the problems of bureaucracies are primarily restorative—they are intended to help ameliorate the severity of these problems and to help maintain the existing form of these bureaucracies. A different kind of response would be to search for innovative alternative systems whose "performance" surpasses existing bureaucracies.

Illustrative of these kinds of activities that may engender responses to surpass rather than merely maintain bureaucracies are the following:

For example, we could:

- Fund small-scale social and technological experiments and provide "social space," relatively free of bureaucratic impingements, within which these innovations can be tested. This might take the form, for example, of a range of different types of small-scale intermediate new communities that employ different technological and social forms to cope with the new scarcity and other problems that beset our larger systems.

- Develop intermediate or appropriate technology that can increase systems resilience by increasing the self-sufficiency of local communities.

- Encourage national opinion leaders to become informed about the role that small-scale, social innovation could play in coping with larger systems problems and begin the process of building greater social legitimacy for action of this kind.

Among these various responses, perhaps the most powerful but most neglected is that of small-scale social innovation. Consequently, it seems useful to explore briefly the present status of small-scale social innovation in our society.

We are blanketed with large-scale social innovations (e.g., social security, food stamps, medicare) and with large-scale technological innovations (e.g., mass transit, space shuttle). There are many fewer attempts at small-scale technological innovations (e.g., new agricultural technologies), and there are extremely few small-scale, diversely conceived, social innovations.

The source of creative social innovations has traditionally been the local government. However, the federal government seems to have preempted many major areas of innovation from the state and local government. Perhaps more significantly, the federal government has sapped the vitality from innovation at the local level. Richard Thompson in his book *Revenue Sharing* (Revenue Sharing Advisory Service, Washington, D.C., 1973), examined the impact of federal funding policies and observed that "the federal government has stepped in and many localities have become administrative mechanisms for implementation of national policies rather than dynamic centers of authority and creative problem solving." In a vicious circle of abdication of responsibility for local vitality, small-scale social innovation is seldom tolerated, let alone encouraged.

There seem to exist two substantial stumbling blocks to small-scale social innovation. First, our cultural "opinion leaders" (in business, government, education, and so on) perhaps do not themselves recognize the crucial role that small-scale social innovation can possibly play in responding to increasingly severe, large-scale systems problems.

Consequently, small-scale social experimentation may be seen as an activity of only peripheral significance. Yet, support of the larger society appears important since truly creative innovation requires a willingness to risk the possibility of failure.

Few people at the grass roots level seem willing to engage in such risk taking without the tolerance and support of the larger community—particularly when the payoff is not windfall profits to an individual but greater resiliency of our social structures. Even if contemporary opinion leaders did no more than publicly acknowledge and affirm the importance of small-scale social experimentation, it could still result in an outpouring of creative talent.

A second barrier to innovation is that such experimentation can be viewed as a threat to existing institutions (whose participants may not perceive the larger, longer-term threat of a systems crisis). Existing institutions may act in self-defense and attempt to prevent social innovation by engulfing the process in so much "red tape" that it never gathers the momentum or the social space necessary as a precondition to success. Thus, there needs to be sufficient "institutional relaxation"—providing social space relatively free from bureaucratic impingement—to allow these small-scale, social experiments to emerge of their own accord. The advice given by Donald Michael in his book *The Unprepared Society* a decade ago seems even more relevant today in suggesting that the right place to initiate the process of social learning

... may very well be in a "societal interstice" where there may develop or be preserved a different standard and lifestyle. Thereby, at some later, more propitious time, this enclave or subculture could serve as a model for many other people as our larger society struggles to find its confused and dangerous way.

Evolution is not stasis. Everything alive is impermanent. If our bureaucracies are alive, they will assuredly prove to be impermanent as well. One direct way to recognize the life and vitality of our social systems is by fostering diverse social experimentation so that, in due course, existing social forms may gradually yield to the new forms they have helped to create. ☛

Authors' Note: The conclusions in this article reflect the opinions of the authors but rely upon a diverse body of literature. References to these resources may be found in the technical paper on which this article is based, "Limits to the Management of Large, Complex Systems" by Duane S. Elgin, prepared as part of the project on *Assessment of Future National and International Problem Areas*, Project 4676, prepared for the U.S. National Science Foundation by SRI, Inc., Menlo Park, California 94025, 1977.