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THE PRESIDENTIAL ADDRESS: CUMULATIVE CHANGE IN THEORY AND IN HISTORY*

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A comprehensive overview of the literature on social change would almost certainly bewilder the uninitiated person should that individual have the patience to undertake so arduous a task. The observer would find that the spectrum ranges from Robert Nisbet's (1969:197) denial of change, there being only a "finely-graded, logically continuous series of 'stills,' as in a movie film. . .," to Wilbert Moore's (1963:11–2) assertion that change is ubiquitous. Running the gamut, it seems that change covers any difference between before and after states, regardless of the units affected, the magnitude of the differences, the time interval involved, or the repetitiveness of the difference. What is true in the aggregate, of course, is not true of individual scholars. Each has employed a definition designed for a particular purpose. I shall do likewise. By social change I mean any nonrecurrent alteration of a social system considered as a whole. The term *nonrecurrence* in the definition is intended to exclude rhythmic events, such as the waking-eating-sleeping round of the diurnal cycle, daily trips to and from work or school, the annual cycle of holiday festivities, the succession of generations, and other such pulsations. These are the means by which a given pattern of relationships is sustained rather than altered. A more difficult exclusion concerns short-term variations around a central tendency, inasmuch as they usually are recognized as such only in retrospect. Try as we might, we have perfected no way of recognizing such variations for what they are at the time of their occurrence.

Nonrecurrent alterations appear in many forms. Of these the most significant, if least dramatic, is what may be called *cumulative change*. This may occur as a single increment to the content of a social system or it may be comprised of a series of increments, each of which prepares the way for the next. In either case it constitutes growth of the system, a movement from small and simple to large and complex.

Why, it is reasonable to enquire, should one expect to find growth or cumulative change in social systems? Various answers suggest themselves. One rests upon an analogy with change in biological organisms. That the organism begins with a fertilized cell which, under appropriate conditions, subdivides repeatedly to produce increasing size and structural elaboration is common knowledge. Whether the processes involved in that phenomenon have counterparts in the growth of the human social system is too debatable to occupy us here. A second kind of answer to the question of "why cumulative change?" may be found in an argument from history. The historical record enumerates many instances of the rise of empires and of civilizations from small and simple beginnings. The fact that many have declined and disappeared does not gainsay the tendency to cumulative

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change. It merely poses another problem. Lessons from history are most convincing, however, when they can be shown to conform to a pattern that can be stated as a set of principles. That, if it can be demonstrated, would constitute a third and most satisfactory answer to the question.

The issue, then, may be stated as: Is there a pattern in cumulative change? To pose the question in this manner may seem to minimize the part decision processes play in change. No one can deny that individuals calculate means to ends. But whether purposefulness in the individual has any necessary outcome in the aggregate is moot. In any event, I do not wish to be mired in an attempt to distinguish intended from unintended effects. The question to be considered here is simply: Are there kinds of events or circumstances which lead inexorably toward cumulative change? In my following remarks I shall treat this question by exploring the implications of three ideas current in much of our thinking, namely, irreversibility, evolution, and expansion.

Irreversibility

The notion of directionality in change rests upon the assumption of irreversibility. This assumption is also basic to a holistic or social system approach to the treatment of change. Irreversibility may be due, as A. J. Lotka (1924: chap. 3) has pointed out, to the mere improbability that elements, after having been moved about randomly, can be immediately restored to their original order. The experience of picking up a deck of cards that has been dropped to the floor illustrates the point. That may seem to have a parallel in instances in which a major catastrophe so disorders the relationships in a social system that they cannot be reconstituted in the prior pattern. Such a situation, however, bears a closer resemblance to an omelet than to a disordered deck of cards: in neither case can the new arrangement of substances be unscrambled. But there is a third circumstance producing irreversibility. That occurs with the creation or emergence of new properties when previously separated organic units are brought into interaction with one another. The relationship thus formed is not inherent in any of the individuals.[1] While some relationships may be terminated, others may not, for interdependence is a survival imperative. The Hobbsian contract is not one that can be readily broken. Irreversibility is thus a condition of structural accumulation as well as of structural rearrangement. As applied to system change, irreversibility does not preclude the possibility of decline and even disappearance. It means rather that the succession of events by which a system was brought to a given state cannot be followed backward to a starting point. A different path must be followed in decline and it, too, moves through a nonreversible sequence.

Perhaps all of this is familiar enough, but an implication often overlooked, binding though it may be, is that the explanatory principles developed at one level of integration are not applicable to another level. To declare with Professor Homans (1964) that this conclusion is false because no satisfactory principles of explanation for higher levels of social integration have been demonstrated begs the question. What is at issue is how problems are stated, the selection of variables, and the modes of operationalization of variables. Nor has it been convincingly shown, contrary to the arguments of methodological individualists (cf. Watkins, 1953), that attitudes, perceptions, and other such conceptualizations are any more palpable than are relationships and combinations of relationships. No one, to my knowledge, has yet reassembled the whole human being from the many analytical abstractions employed in the pursuit of generalizations.

The reductionist is usually misled by a methodological tactic which the holist uses when engaged in quantification. To describe a population as consisting of so many individuals is no more a confession that the ultimate reality is the individual than is the measurement of a farm in acres

[1] "Whenever certain elements combine and thereby produce, by the fact of their combination, new phenomenon, it is plain that these new phenomena reside not in the original elements but in the totality formed by their union." (Durkheim, 1938; pp. xlvii)

of land an admission that only an acre is real. Similarly, while a single birth is an individual experience, a birth rate is a structural feature, and the explanations of the two facts may have little in common. The aggregate, the reductionist's conception of social reality, may be just an aggregate if composed of units thrown together simply because they conform to a given definition. But, if the aggregate is not the product of a statistician's convenience, then an explanation of its existence must lie elsewhere. Pursuit of the *elsewhere* takes one to a social structure.

It seems, then, that a theory of social change cannot be designed to explain both individual variations and social system variations, as Gudmund Hernes (1976) would have it. The individual life cycle has no counterpart in the duration of a social system. Functional positions can remain constant despite the turnover of incumbents. That the converse is true seems very unlikely. Change in a social system alters the life conditions of all participants and they must adapt in order to remain in the system. Irreversibility is the bridge linking levels of integration, the similarities among which lie mainly, if not exclusively, in analogy.

Evolution

Irreversibility is an elemental assumption in the theory of evolution.[2] Whether that concept is transferable from biotic to social levels of analysis depends a great deal on how it is interpreted. Certainly attempts to draw very close parallels between levels risks falling into the reductionist fallacy. The principle of irreversibility tells us there can be no general law of evolution operating across all system levels (Jacob, 1977). The properties distinguishing one level of integration serve as postulates for the next higher level. But the hypotheses designed to account for phenomena at the higher level must be cast in terms of the peculiar constraints that operate in and upon that level. Yet there are two respects in which the evolution concept has a generic meaning. Substantively, it implies a change from simple to complex forms.[3] Analytically, change is viewed as proceeding through variation of units and natural or fortuitous selection. A necessary caveat in this latter respect is that the selection hypothesis is a tautology, albeit a highly useful one; but like all tautologies it suffers from a two-way causation. A point too little stressed is that societal evolution appears to be a Lamarkian rather than a Darwinian phenomenon.

One of the characteristics of traditional evolution thinking is the notion of discontinuity in change, or of change as moving through a stage-like progression. The simplicity of the stage concept is beguiling, despite the precariousness of the implied equilibrium assumption. It is doubtful, however, that an equilibrium assumption can be escaped, not even by those who argue that change is imminent, for change can only be imminent when there is not-change. Equilibrium waits in the wings of the mind to move to center stage at every recognition of unit character. And, without the supposition of unit character, order in the universe would not be conceivable. More to the point of this discussion is the need for some means whereby historical time can be converted to analytical time. The stage concept serves that purpose for better or for worse. Despite its many detractors, the concept has shown remarkable vitality. It is an essential ingredient in the bioecologist's concept of the ecosystem, which has its emulators in social science, and it lives on in the social evolutionist's chronology of societal types.

It is noteworthy that biologists have turned from typological to probability models when the concern is with the phylogenetic problem, but they employ an equilibrium model when the ecological problem arises. The difference is more than a matter of preference; it points to a distinction between evolution and growth. Evolution deals with the appearance of new species or forms of whatever kind,

[2] A more fundamental application of the term occurs in astrophysics. See Benjamin Gal-Or (1972).

[3] G. E. Swanson (1971:3) uses the term to mean "capacity to exploit environment." This usage verges closely upon the meaning of progress. I prefer a more neutral conception.

while growth pertains to the maturation of a form to a point at which, presumably, the form is capable of reproducing progeny which are then subject to natural selection. In contrast to the variation-selection model of evolution, the growth model is best represented by the logistic curve. There is much less consensus on what takes place in the passage along the curve. If we can resolve that difficulty, we may be in a position to determine how the two concepts accord with the history of societal development.

Expansion

What is meant by cumulative change requires a definition of a social system. That term, as used here, denotes an arrangement of routine activities or roles and relationships by which a population sustains itself in a given environment. Cumulative change, then, refers to increase in the number and variety of roles and relationships. Such increase, however, cannot proceed far without increases in population and in territory. Population increments are needed, not just for the augmented variation it brings, but also to staff the growing structure of roles and relationships. Added population is needed also to provide a clientele, i.e., a market, for any increases in productivity that might occur. Differentiation without a market is like a building without a foundation. Increases in structural complexity also make demands for access to an enlarging territory from which to obtain food and raw materials and in which to find room for the conduct of activities. Complexity and scale are intimately linked, though the linkage may not always be superficially evident. Hence the use of the term expansion to characterize societal growth.

So far as I am aware, Lenski (Lenski and Lenski, 1978) is one of the few students of evolution to give even casual reference to expansion. Dudley Duncan (1964; see also Eisenstadt, 1964), who shares the interest in evolution, suggested that expansion may be the key to the transition from one major level of social evolution to another. But very little systematic work on the concept has been forthcoming. The term has been commonplace in the historical literature for many years, but it has been used merely to describe particular series of events, instances of which crowd the historical record (Gras, 1922; Woodruff, 1966). Braudel (1966:660) speaks of the "logical laws of expansion," but I have been unable to find them in his work. Occasional efforts to generalize the historical experience have been made, but those have been incomplete (McKenzie, 1934; Hawley, 1950: chaps. 18, 19, 20; 1971; Gutkind, 1953; Quigley, 1961). Empirical studies, of which there have been many, have dealt mainly with events at the margins of expanding systems (Wilson and Wilson, 1954; Gough, 1955; Rao, 1970; Vidich and Bensman, 1960). More recently, the growth of interest in world systems promises a use of historical materials in a systematic development of the expansion concept (Wallenstein, 1974; Choucri and North, 1974). Very little of this work has found evolution theory a helpful basis from which to proceed. That may be because a point is reached in the growth of social systems beyond which evolution theory is no longer helpful. I will want to return to this suggestion later in my remarks.

Whether the process of cumulative change leads to evolution or growth depends, other circumstances constant for the moment, on how concurrent are advances in complexity and scale. There have been many instances in the past in which population has increased significantly without corresponding increases in structures, as a result of reductions of enemies or of windfalls in the food supply. If the loss of proportion between the population carrying capacity of the system and the number of people on hand is the only disturbance that has occurred, the effect is a budding off of colonies. The colonies move off in search of niches in the environment in which they might settle. They may be likened to progeny possessed of a range of variability and subject, therefore, to selection by environment. Some survive, and in doing so adapt their structures to new circumstances. Others succumb as a result of their inability to come to terms with unfamiliar environments. In this way evolution of social systems may be con-

ceived. That is, through a combination of happenstance and adaptive success one or more complex or advanced social systems are produced (cf. Simpson, 1967; Jacob, 1977).

On the other hand, when complexity and scale advance more or less together, the effect is growth or expansion rather than evolution. But now it is necessary to enquire into how that process is begun, for that it can have a spontaneous causation is most unlikely. The axiom that a thing cannot cause itself is as applicable here as elsewhere.

The normal, if not the necessary, condition for expansion arises from the colonization process described in the preceding paragraph. A spread of settlements over an area, under appropriate conditions, may create a social field, a universe of more or less frequent interactions among the settlement units (cf. Lesser, 1961; Wilkinson, 1970). A field may be visualized as a territory over which the several settlements, or centers, each with a tributary area differing in scope and resource composition, are variously linked in a common transportation network. One or two of the centers is situated at the intersection of intra- and interregional routes of travel, a much larger number are located at the crossings of internal thoroughfares, and some are found at the extremities of interior routes. The field notion, it will be noticed, substitutes an assumption of interdependence of units for the assumption of independence in evolution theory.[4]

Social fields are a commonplace in historical experience. History describes a western succession of such interaction networks. One of the earliest recorded centered upon Babylon in the Euphrates valley. It was followed by a field of greater dynamics in the Mediterranean region where Miletus, Athens, Alexandria, Rome, and Constantinople served successively as focal points. Still later, ascendancy shifted to northwestern Europe from which subsequently the interaction network was extended more and more widely.

Within an interaction field, disequilibrium, which is a requisite for system change, is a chronic condition.[5] Not only are there disturbances arising from the biophysical environment, but also each center is exposed, unequally to be sure, to repeated challenges from the social environment. Travellers circulate through the network, bearing ideas, experiences, and artifacts, that is, information and misinformation, originating from local and extralocal sources. Information piles up, as it were, in the most accessible center and drifts outward to the less favorably located centers. Of all the kinds of information that flow into and through the network, those which affect facility in movement are doubtlessly the most critical. As Joel Smith (1968) has pointed out, they determine the measure of accessibility, set the terms of expansion, and ultimately, as we shall see, impose limits to growth. If invention is a drama enacted on a crowded stage, as Michael Polanyi (1959:117) has said, there must be means for bringing actors with diverse experiences together. And as inventions enter into use they call new relationships into being, every one of which involves a transportation of some kind. Technical accumulation begins in mobility and is sustained by mobility.

As a general proposition it may be stated that the complexity and scale of a social system are a joint function of the efficiency of its techniques for the movement of people, materials, and information. Efficiency is measured most cogently by the number of activities that can be articulated per unit of time and cost. It derives partly from the tools for movement which, together with the knowledge for their fabrication and use, comprise what is ordinarily regarded as technology. But efficiency rests also on the less obvious, though no less important, organizational arrangements essential to the application of the tools. The relays of messengers employed for the integration of ancient empires was an organizational

[4] This distinction also has been recognized by Donald Campbell (1965) in his paper on "Variation and Selective Retention in Socio-Cultural Evolution."

[5] According to Göster Carlsson (1968), the rate of change varies with the extent of disequilibrium.

device. So also are the freight forwarding agency, the commercial bank, and the insurance firm of a much later period. A more subtle number of this class is standardization of the terms of discourse, including language to be sure, but also weights and measures, coinage, units of time, rules of the road, standards of judgment, and, above all, forms of organization. The technology for movement is in no sense peculiar in its composition. Tools and organization are two sides of the same coin. Technology is nothing more nor less than the instrumental aspect of culture (Boulding, 1969).

These distinguishable components of technology are often staggered in their development. In many instances it seems that the tool appears before an effective organization for its use has been devised and that happens before the many adjunctive behaviors have made their accommodations. Alfred Chandler (1977; see also Taylor and Neu, 1956) describes how experience with the administration of the railroad had to accumulate before a solution was found in an hierarchical management structure some twenty years (in the 1860s) after the steam railway was introduced. But another twenty years passed before a standardization of time and of track gauge were accomplished, in the 1880s. One of the more time consuming phases of standardization, especially where relationships are bridging cultural differences, is with reference to forms of organization and the procedures by which they operate. For that requires a resocialization of not just the few users of the imported tools but of large sectors of a population and eventually of the entire population. In the end the effect will occur if the relationship is uninterrupted and if it has gained vital significance.

The tool-organization-standardization sequence creates conditions out of which other, different sequences unfold. For example, the effects of standardization as a facilitator of movement are not confined to one range of events. The standardization of railroad track gauge in the United States opened wider the gates to interregional flows of information and, thus, increased opportunities for invention. Similarly, an organizational form developed in connection with the application of one mechanical eontrivance is often transferable to others. Chandler (1977: chap. 9) makes a point of how the management structure devised for the dispersed operations of the railroad became a model for other large-scale enterprises. An exogenous influence rarely ends with a single response in a system; rather does it produce a concatenation of effects that terminates only when the system has completed its absorption of the new element. The process, comprising numerous feedback loops, gives to cumulative change a helical pattern of progression.

In the context of the interactive field the cumulative process is most rapid in the strategically located center. Accordingly, it gains an increasing capacity to mediate and coordinate a diversity of activities scattered over a widening area. The expansion process, as McKenzie (1934) observed some time ago, involves countervailing currents of redistribution. A centripetal movement of selected specialists and ancillary workers parallels the centralization of information to develop the institutions through which a center grows in size and in administrative power. A centrifugal movement of explorers, raw material extractors, processors, and managers carries technical acquisitions into resource developments on a receding frontier. Thus the field becomes organized in a hierarchy of centers and local tributary zones with the result that a single expanded system replaces a number of localized and relatively independent systems.

This is a process that can work on any scale, limited only by the technology for movement. As a matter of fact, however, it generates what might be regarded as organizational equivalents of scale. On the one hand, it radically changes the significance of population in local areas. The merging of lesser units into a larger unit is also a pooling of demographic resources. Each subsystem gains the benefit of a much larger labor force and range of skills than it could muster within its original boundaries. This is by way of compensation for the loss of local autonomy. On the other hand, expansion alters the orientation to territory. In the early phases

communications are hampered by organizational differences between center and periphery. In consequence expansion can only proceed by the imposition of the center's institutional forms and procedures upon outlying settlements and that called for political domination of territory. But in the long run sustained interaction proves an equally, if not more effective, and a much less costly, means of producing structural convergence than political coercion. Political domination gives way before an increasing ease of access to territory.

It is true, of course, that in the past processes of expansion have run their course and come to an end many times over. Various explanations of the conclusion of expansion phases have been proposed. Ralph Turner (1941: Vol. 2, 1298), the historian, contended that a system can reach only to the outer edge of the region to which its agricultural techniques are adapted. Neither colonization nor the supply of armies is possible on a sustained basis beyond that limit. Carroll Quigley (1961) finds the end of expansion in the natural decay that sets in when the uses of surplus wealth become institutionalized. As that occurs energies are directed from invention to maintenance of bureaucratic positions. A case in point might be in the institutionalization of slavery in the Roman Empire which, according to F. W. Walbank (1946:19), so impoverished the citizen population that the local market contracted and invention lost its incentives. The sinologist, Mark Elvin, finds a different cause of the termination of expansion. He says that "empires tend to expand to the point at which their technological superiority over their neighbors is approximately counterbalanced by the burdens of size" (Elvin, 1973:19).

Each of these statements describes a conception of how a return to equilibrium comes about. The unspoken assumption in each account is that the possibilities for growth are contained in and limited by a given technology for movement. The limits are approached by virtue of the difference between the exponents of increase in scale and complexity. While numbers of people and of activities increase additively, relationships increase by multiplication. In consequence a rapidly mounting density of interaction generates steeply rising costs of movement of people, goods, and messages. A point is reached in the density curve beyond which the costs of movement are too high to support any further elaborations of structure. Any tendency to exceed that density, ceteris paribus, results in a return to scale, as Boulding (1953) has observed in his seminal paper on a theory of growth. The return to scale in simple systems is manifested in the colonization process mentioned earlier. In more complex systems it may develop as a strain toward decentralization of authority, forming subsystems, and restoring limited degrees of autonomy to local groups.

The growth process can always be resumed, of course, when further improvements in the technology for movement are introduced. Since that is apt to occur in some systems before it affects others, the former tend to expand into the territories of the latter, thereby absorbing them into an enlarging system. Several major mobility revolutions have subdivided Western history into expansion phases. Earliest among these was the transition from animal powered to mechanically powered movement. That began with the reliance upon wind and sail to venture beyond coastal waters and reached a maximum scope with the application of steam power to over-land as well as to over-water movements. In that regime it was possible to extend systems far beyond localities and harness the resources and markets of distant peripheries to center of expansion. It has been suggested that the potentialities of the steam power era were fully utilized by 1870 and that very little change took place in the next several decades (Landers, 1966). But that is to overlook the telegraph, which appeared in the 1840s and launched a second important transition; namely, a separation of communication from transportation. By this means a new dimension was added to the territorial organization of economic, political, and other activities. For the first time central

offices could exercise control on a daily basis over widely scattered branch offices and producing sites. Close upon the heels of the communication revolution came dramatic improvements in the facility for short-distance movement. The telephone and the electric street railway in the third quarter of the nineteenth century and the motor vehicle at the turn of the century gave a new scope to the pattern of local relations which had received only minor alterations since the domestication of the horse. The last of the major turning points has been in the making for some time and is not yet concluded. This is an advancing substitution of communication for transportation. It was initiated with the telegraph and telephone, carried further by radio, radar, and television and has reached a present apogee in satellite and laser beam transmissions. Technical information, management instructions, credit and foreign exchange can now move independently of transportation. Moreover, the reduction of time distances to near zero have all but eliminated the boundaries of systems.

An inference from the hypotheses which has guided this discussion is that efficiency in movement is an accurate indicator of the extent of cumulative change. That admittedly has not been fully demonstrated. There is, however, a mounting volume of evidence to support the argument that a measure of mobility can serve that purpose. Wilfred Owen (1964:14) has shown that freight and passenger mobility are sensitive indicators of the level of economic development. Numerous correlation studies of comparative data reveal measures of communication to be among the most indicative of the level of other measures of development (United Nations, 1968; Olsen, 1968; Cutright, 1963). And Henry Barbera (1978), in an unpublished paper, has effectively predicted the extent of external relation from the assumption that the power of a system is measured by the degree to which internal communications are developed. Mobility measures rival energy production as indicators of complexity or growth. But they are not qualitatively equal. Energy produced and consumed may be highly concentrated in a few localities or economic sectors. Transportation and communication, on the other hand, constitute a more distributed feature of a system.

Conclusion

In conclusion, it appears that the course of history has progressively reduced the utility of an evolution model in the explanation of cumulative change. Although social variation as represented in occupational and territorial specialization has been carried to an unprecedented degree, it does not satisfy the assumption of the model; instead of the required capacity for independence of action, the differentiated parts are inescapably caught up in a tightening web of interdependences. This does not mean an end to, or even a slowing of, change. The accumulation of information in storage facilities—a means of transportation through time—is so vast that generations will pass before its potential uses are exhausted. In the meantime the impetus to change may be expected to shift from center to center, further reduction of cultural differences will occur, and the density of organization on a world scale will continue to increase. But the disappearance of evolution as a mode of change in human social systems, if true, is not without risks. Whereas in the anarchy of a multiplicity of localized systems fatal errors could be made here or there without jeopardizing the survival chances of other systems, that can no longer be expected. The single world system has a limited tolerance for error. It must either acquire methods of anticipating and compensating for significant errors or fail to survive. In that event the evolution process may once again take command of the course of change. The opportunities for speculation on this theme are inviting, but space does not permit me to pursue them.

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