SOURCES OF INSTITUTIONAL INNOVATION:

AN INTERPRETIVE ESSAY

by

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PREFACE

This paper is an interpretive essay based on discussions during a two-day seminar on "Institutional Innovation" at the University of Minnesota on February 10 and 11, 1983. Professor Runge participated in the seminar. Following the seminar he prepared a draft essay. The essay was circulated and reviewed by the seminar participants. It was then redrafted.

The seminar was organized around a number of papers and presentations by scholars with varied interests in the broad subject of institutional design and institutional innovation. (See Appendix A for the seminar agenda).

Burton A. Weisbrod of the University of Wisconsin Department of Economics discussed his research on innovation in non-profit sector institutions. He was particularly concerned about how information asymmetries between the suppliers and users of health care facilities interact with the structure of the health care industry to induce differences in performance. He found that preferences by users for public or non-profit institutions often reflect the extreme difficulty of obtaining objective information about the qualitative dimensions of health care. In such cases users tend to substitute judgements about whether an institution is worthy of trust for information about institutional performance.

Alan Kneese, Professor of Economics at the University of New Mexico and Senior Fellow at Resources for the Future, discussed institutional innovation in the context of comparative regional river basin planning and

environmental management in the United States, France, Germany, and Great Britain. Kneese was particularly concerned with the differences among the several countries in the ways that scientific and technical knowledge and expertise was brought to bear on the design of environmental institutions. An important unresolved puzzle was the apparently conscious effort by the political system to exclude social science knowledge and expertise from the design of U.S. environmental institutions.

Robert E. Evenson, Professor of Economics in the Economic Growth Center at Yale University, analyzed the evaluation and current status of the international patent system as an example of changing intellectual property rights and the implications of these changes for technology transfer from developed to less developed economies. He discussed a number of institutional innovations such as utility and design patents that have been used to stimulate "downstream" inventive activity and more rapid technology transfer. Evenson also stressed the trade-offs between the positive impact of international intellectual property rights conventions in encouraging trade in intellectual property and the negative impact that such conventions may have on legal innovations designed to encourage indigenous inventive activity.

Jonathan Hughes and Stanley Reiter, Professors of Economics at Northwestern University, presented a joint paper combining the formal modeling of regulatory constraints with use of the model to interpret U.S. regulatory history. In their model regulatory activity is viewed as an endogenous response to the acquisition of sufficient political resources on the part of farmers, workers and consumers to enable them to compete in the political market place with commercial industry. But unlike many other observers they conclude that the continuing bargaining over the partitioning of the new income streams generated by economic growth is "a positive sum game."

The first day of the seminar concluded with a broad discussion by Robert McC. Adams, Professor of Archeology and Provost at the University of Chicago, and recent chairman of the Committee on Basic Research in the Behavioral and Social Sciences of the National Academy of Sciences. He outlined the contributions of sociology, geography and anthropology to understanding of the process of institutional innovation. Adams also made a strong appeal for a culturally specific organic (or phenomenological) approach that would start by trying to understand the world in terms that are meaningful to the actors involved. He was critical of attempts to understand the process of institutional innovation from a more universalist or positivist perspective.

The second day of the seminar was devoted to more general discussion. Robert Keohane, Professor of Political Science at Brandeis University, discussed the implications of institutional innovation for political science studies in a national and international context. He noted that the model of endogenous institutional innovation employed by several of the economists was too narrow for his taste. But Keohane also argued that because of its potential power the economists should be encouraged to continue to test the theory of endogenous institutional innovation against historical experience. The conference was concluded with a synthesis of previous discussion and a proposed agenda for research by Leonid Hurwicz. The Hurwicz presentation was followed by a short planning session devoted to a discussion of issues that might be discussed at future meetings.

The seminar on Institutional Innovation was the outcome of a continuing collaboration between a Faculty Study Group at the University of Minnesota and the American Academy of Arts and Sciences. In the Fall of 1981 an

interdisciplinary faculty group at the University of Minnesota with representation from Law, Sociology, Political Science, Philosophy, Geography, Anthropology, History, Engineering, Agriculture, Business and Public Affairs initiated a series of seminars to explore the interrelationships between technical and institutional change. As the seminar progressed increasing attention was focused on problems of institutional design and innovations. (See Appendix B for the list of topics discussed by the Faculty Study Group.)

The initial inspiration for organizing the Study Group came from the 1981 spring meeting of the Council of the Midwest Center of the Academy. There has been a continuing dialogue with Academy officers and staff in both Cambridge and Chicago about seminar ideas and topics. In October 1981 the Academy provided support to bring Theodore W. Schultz and Robert C. Sachs of the University of Chicago to the Minnesota campus to dialogue with the University of Minnesota Study Group. The Academy also provided travel support for the off-campus participants in the February 1983 seminar.

The Minnesota Faculty Study Group and the Academy are now exploring the possibility of organizing a more formal seminar around issues of institutional design and institutional innovation. The February 1983 seminar confirmed our perception that understanding of the process of institutional innovation is woefully inadequate. At the same time we were also convinced that some progress has been made and that further advances are possible. The ability of a diverse group of scholars from the humanities, social sciences and natural sciences to fruitfully engage in dialogue around the issues discussed at the seminar organized by the University of Minnesota Study Group has been highly encouraging. The ability to engage in fruitful dialogue about both the empirical and conceptual foundations of the case studies presented at the February conference was also encouraging.

The discussions of the Minnesota Faculty Study Group Seminars and at the February Academy-Minnesota conference revealed considerable disagreement about the appropriate approaches to understanding the process of institutional innovation. The discussions were continuously confronted by two questions:

- Are there universally valid analytical approaches to interpreting the process of institutional change? Or must the interpretations be culturally specific?
- How free is society to choose the path of institutional change it will follow? Is society as free as planners frequently assume to design new institutions? Or is institutional design dominated by historical or evolutionary forces?

These differing perspectives are reflected in our own approaches to the process of institutional innovation. Research by Hurwicz has been guided by a design perspective. In his work a major analytical hurdle that must be resolved in designing more efficient institutions centers around the difficulty of resolving the contradictions between individual and group behavior. In social systems in which information is decentralized there is a conflict between the desire for information efficiency and the need for incentive compatibility.

Research by Ruttan has been guided by an evolutionary perspective. His major interest has been an attempt to understand the historical processes that give rise to institutional innovation. In Ruttan's perspective the rate and direction of institutional change is seen as an economic response to changes in resource endowments, technical change and advances in social science knowledge.

There are, however, several areas in which our research is complementary. The empirical generalizations employed in the Hurwicz analysis are based on historical insights into the process of institutional change. Ruttan's historical analysis is guided by the emerging theory of collective action. Both Hurwicz and Ruttan view advances in social science knowledge as contributing to more efficient institutional design and as reducing the cost of institutional innovation.

As our dialogue has progressed it seems apparent that one might frame these issues in the form of a matrix:

INSTITUTIONAL INNOVATION

SOURCES	APPROACHES: Organic	APPROACHES: Analytical
Evolution		
Design		

A better understanding of these interrelationships is critical if social scientists are to contribute more effectively to the understanding of the processes or to the design of institutional innovation. Most social science theory takes the institutional environment in which individual and group decisions are made as given. This perspective is excessively bound by time and space. In our view the value to society of social science research, and of advances in social science knowledge, must be evaluated primarily in terms of its contribution to the design of more efficient institutions and to the realization of more efficient institutional performance.

The dialogue at the Minnesota Study Group seminars and at the Academy-Minnesota conference have confirmed our judgement that the study of institutional change can be organized to advance our capacity to consciously design institutional changes in response to changes in the social and economic environment. It is also clear that the design of more efficient institutions is both constrained and enhanced by resource and cultural endowments and by concurrent changes in technology. We anticipate that some of these questions will be addressed in a subsequent conference.

Leonid Hurwicz

Vernon Ruttan

SOURCES OF INSTITUTIONAL INNOVATION: AN INTERPRETIVE ESSAY

Carlisle Ford Runge*

Introduction

In the course of the two-day seminar, institutional innovation was addressed from a variety of perspectives, resulting in a fascinating but diffuse set of insights. The fundamental problem, outlined by Ruttan, concerns the absence of a well-developed theory linked to empirical studies which convincingly explains the supply of institutional change. A first question motivating the conference therefore was: what factors lead to the supply of institutional innovations in particular environments of choice? A second question, raised most forcefully by Hurwicz, concerns the sources of this supply. Can institutions be "designed" by reference to some set of normative criteria? If so, are these criteria sufficiently general to be applied in many contexts, or are they bound to specific cultural practices and environment? Although difficult to summarize, a number of problems and issues cut across the discussion of these questions. This short paper interprets them from the perspective of one participant, and identifies some important areas for future discussions and research. These items are organized around three major headings.

- Abstract and Substantive Approaches
- Information and Uncertainty
- Institutions and Technology

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The first section lays out the problem of identifying a unified concept of institutions and institutional alternatives in terms of a "map" of these alternatives. It argues that such a construction requires both the orientation provided by abstract theory and the substance of detailed empirical investigation. The second treats the issue of information and uncertainty running through many of the discussions and papers. The third takes up some specific links between institutional innovations and technological change. A last section concludes with the general implications of these issues and problems for the possible direction of future research.

Abstract and Substantive Approaches

Institutional innovation is both an abstract issue in need of formal analytical treatment and a substantive question requiring specific cases and examples. To be relevant, abstract approaches must be linked to empirical studies of institutional change. To be rigorous, however, the study of institutional innovation cannot proceed by case studies alone. A general approach must provide both abstract theory yielding general hypotheses and substantive investigations testing these hypotheses on a case basis (see Gordon, 1976).

Leonid Hurwicz likened the problem to the development of a map of "institution space."[1] In order to construct such a map, we first need an abstract conception of direction, an orientation resulting from the demarcation of institutional alternatives according to an accepted set of coordinates. The role of theory is to provide such direction so that even if disagreement exists over where we ought to go, we are at least referring to the same point. Second, we need to know the features of the institutional terrain, the location of current institutional alternatives, and the most direct existing routes from one alternative to another. We may then want to determine where new routes and locations should be built recognizing that these new ways and stopping points will be matters of normative disagreement. In combination, abstract theory and substantive examination of the institutional terrain will allow us to organize such a conceptual map.

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[1] A similar reference to an institutional "periodic table of the elements" was suggested. I leave the elaboration of that metaphor to others, with the brief comment that it is the complex chemistry rather than the constituent elements of institutions which seems most important. These elements are generally individuals.

Rigorous abstraction, while necessary to orient a search for institutional alternatives, is not sufficiently detailed to discriminate features which may be critical in determining the most appropriate routes and stopping points. The higher above this terrain we move in abstraction, the less discernable these features become.

The distinction between abstract and substantive approaches is consistent with John Rawls' definition of an institution as a "public system of rules." These rules may be defined abstractly as a possible form of conduct expressed by such a system. A second, more substantive definition is as the actual realization in the thought and conduct of certain persons of the actions specified by these rules (Rawls, p. 55). This approach allows both rigor and relevance, from abstract social choice theory to comparisons of the intergovernmental characteristics of water basin planning institutions.

Numerous seminar participants observed that a more unified approach to the sources of institutional innovation requires a distinction between positive issues of where we are and have been institutionally, and normative issues of where to go and how to get there involving the "designer's point of view." Normative disagreements over where to go and how best to get there depend on the institutional terrain to be crossed. In studying this terrain, insight is required into the web of values and beliefs leading to decisions to modify (or the failure to modify) certain rules in response to changing needs or conditions.

When the historical record is examined, it is difficult to separate conscious decisions to alter social and political institutions from the larger forces which seem to make such changes an inevitable evolutionary response determined by changing circumstances and events. "Design" confronts

the random or uncontrollable effects over which individuals have no power. Nonetheless, successful institutions may be designed in such a way that they are robust in the face of changes which no institutional architect can predict. The existing features of the institutional terrain are thus the past efforts at adaptation, weathered and shaped by the forces of history and time. Some institutions become mere ruins, others survive and are built upon by each succeeding generation.

In the case of Argentine agriculture discussed by Ruttan (1981, pp. 239-70), the price of land in relation to "landesque" capital was biased in part by the distribution of rural landholdings. This distribution of property rights, which led to class conflicts within the agricultural sector, was a specific adaptation of institutions to an environment of choice and an important feature of the institutional landscape. In this and other cases, the existing distribution of land and wealth may pose an insurmountable obstacle to institutional change. Whether these distributions are the "best" adaptation or whether they should be modified is a normative judgement. In a separate example, the institutional alternatives in river basin planning discussed by Kneese (1968, pp. 255-97) were the result of different views over the proper role of regional authority and economic incentives in pollution control. While partially drawn from scientific and technical analysis, the institutional forms chosen also reflected the political values of the countries concerned. These values led some decision makers to treat the "right to pollute" as subject to modification and others to consider it fixed and non-negotiable.

In substantive cases positive and normative explanations of institutional innovation are therefore difficult to separate. Institutional modifications which appear most efficient to the economist may not be compatible with the

incentives of particular groups of individuals who possess the power to block the route to their implementation. The designer recognizes that some of the obstacles are moveable or can be circumvented and others cannot. Since the power of certain groups may dominate design considerations of economic efficiency, institutional alternatives require the identification of both competing normative views and the power behind them. More abstractly, determining which institutional alternatives are feasible requires an understanding of both the material and behavioral circumstances of those involved in the decision to innovate. What is feasible in turn depends on a judgement concerning those aspects of existing institutions which the parties consider it desirable to change (Hurwicz, 1972, p. 37).

In the language of theoretical welfare economics, institutions, like technology, are part of an outside environment which determines the initial allocation of resources. When institutions are no longer considered part of the environment, judgements concerning the distribution of resources become matters of choice. Evaluating these choices raises the familiar problem of an appropriate social welfare function or family of functions (Arrow, 1962).

Conflicts over the definition and implementation of alternative notions of social welfare are a primary concern of sociologists and political scientists. Anthropology broadens this to include a comparative study of an entire family of social welfare functions including not only political and social institutions but cultural practices as well. For economists, treating institutions as part of the choice mechanism rather than as part of the environment necessarily implies the relevance of these other disciplines. Again, a neutral neo-classical posture respecting questions of distribution is difficult to sustain. To pursue our metaphor, the abstract theoretical orientation provided by economics must consider the institutional landscape in

more dimensions, including the obstacles and opportunities posed by political, social and customary norms. This suggests that the Pareto criterion relied on for so many judgements in economics is insufficiently general in matters of substance.

These daunting complexities at the substantive level may give haste to a retreat into abstraction. Here too formidable problems exist. However, theories of institutional choice based on the application of game-theoretic and information-theoretic tools have attracted increasing interest and show considerable promise. The outcome function developed by Reiter and Hughes (1981, pp. 1381-1421) and the characteristic functions cited by Hurwicz and discussed in Shubik (1982) represent instruments with which to construct a more general theory of institutional innovation. Reference should also be made to the work of Hardin (1982), Schotter (1981), and Thompson and Faith (1981). These formal descriptions may explain institutional innovation in terms of choice mechanisms which are difficult to modify in substance but may be manipulated in the abstract, yielding new insights into the opportunity set of institutional alternatives. Formal explanations can also attend to some distributive dimensions. One relatively modest attempt is the treatment of alternative income distributions in terms of the shadow values or weighting functions associated with equity constraints in World Bank projects, prototypes of institutional and technological innovation (Helmers, 1979).

Given the complexity of institutional processes, the current absence of a unified vocabulary at both the abstract and substantive level of discussion is not surprising, and is in fact characteristic of the early stages of any field. Among the definitions and approaches to institutional innovation currently pursued, Keohane noted four in use during the seminar. The first and most specific is Weisbrod's "institutional mechanism," defined as a

"socially imposed constraint on behavior" such that the objectives of economic agents are pursued inside of these constraints. Weisbrod argues that institutional mechanisms arising in any area of economic activity, such as health care, may be conceived as a menu or opportunity set of constraints. In nursing homes, for example, they range from government homes to private non-profit facilities to private for-profit enterprises, each with its own set of characteristics. This definition brings institutions from the environment into the realm of choice by linking the characteristics of institutions to the information needs of the agents so that the particular type of constraint chosen is a function of the information requirements of these agents.

A second, closely related definition by Ruttan (1979; p. 32), based on earlier work by Knight (1952), is more general: institutions are the behavioral rules governing individual behavior. Institutional innovation is thus "a change in the actual or potential behavior or performance of existing or new organizations; in the relationship between an organization and its environment; or in the behavioral rules that govern the patterns of action and relationships in the organization's environment." Institutions are considered to include organizations. This definition is closely related to the sociologists' "norms," and is broadly inclusive of customs, organizational procedures, and other mechanisms of social control (Ruttan, 1979, p. 32).

A third and related definition is more general still: institutions are the solution to "coordination problems" which order the expectations of individual actors respecting the likely behavior of others (Hardin, 1982, Hayami and Ruttan, in press; Runge, 1981b; Schelling, 1960; Ullman-Margalit, 1977). Originating in Schelling's fundamental reorientation of game theory around a continuum of games from "pure-conflict" at one extreme to "pure coordination" at the other, this approach identifies institutions as rules or norms which are innovated in order to advance the interests of the parties and

subsequently used to fix expected behavior. A simple example is the convention of driving on the right-hand side of the road. Winston Churchill's traffic accident while visiting the United States resulted from stepping into traffic due to a false expectation that it flowed from the right. This expectation resulted from adaptation to conventions of behavior in force in London but not in New York.

Under this definition, the choice of institutions is made in light of the comparative benefits and costs of successfully ordering individual expectations by reference to some rule or agreement. The survival or modification of such rules is in turn a function of their continuing success at conveying the net benefits of coordination, increasing the scope of certainty or assurance in an environment of general uncertainty over the likely actions of others. This abstract definition may also be applied more substantively. By defining rights and privileges, responsibilities and obligations, and the exposure of individuals to the rights and responsibilities of others, institutions reduce uncertainty in particular choice environments and confer increased value to agreements of future economic activity (see Commons, 1924). Institutional innovations correspond to technological innovations in the sense that they confront uncertainty as a group "tool," extending the attainable set of possible solutions to problems of production and allocation. Unlike technical innovations, which are nearly always compatible with individual incentives for increased production, institutional innovations depend on the development of cooperative rules compatible with the incentives of the group (see Hurwicz, 1972). At a

substantive level, however, positive and normative distinctions are again problematic. Since institutions are tools wielded by the group as a whole, the incentive to adopt a particular institution includes not only increases in production but also the distribution of resources. Hence the adoption of particular institutional "techniques" is a question of competing views of social welfare.

In sum, this definition emphasizes the general relationship between institutions, expectations, and uncertainty, arguing that successful institutional innovations give greater order and stability to individual anticipations of future events. By reducing uncertainty, institutions set rules which convey critical prior information to individual actors, leading to a choice environment in which streams of future benefits are expected with greater assurance (Runge, 1981a).

The fourth and most general definition of institution encompasses all the varieties of culture, described as alternative responses to different environments and historical circumstances. As developed in Robert Mc C. Adams wide-ranging discussion of culture change, this view emphasizes the role of institutions in history and draws together a variety of disciplines often left untouched by economists disinclined to adopt an historical approach. Sociology, anthropology, geography and other disciplines increasingly focus on cultural variation as an adaptive response to environment, with an emphasis on the difficulty of predicting institutional innovation a priori. Like the third definition, this one emphasizes adaptation to environmental uncertainty as a leading explanation of culture and thus institutional change. This supports an interpretation of institutions as an evolving and changing

landscape, redefining their contours in response to a variety of ecological pressures. Even more than the other definitions, this historical emphasis tends to eschew abstraction in favor of specific and substantive cases in which positive and normative distinctions are difficult to sustain. The unique cultural context of each society makes universal analytical distinctions difficult to sustain and generalizations based on such distinctions of limited assistance in understanding the myriad shapes and contours resulting from an organic process of cultural change affecting human institutions. And yet, if each society is judged only by the substance of its own standards, no abstract understanding of the full institutional landscape can be grasped. An interesting recent case of this difficulty is the anthropological debate over the revision of Margaret Mead's Samoa findings, which recent critics argue were informed by abstract comparisons with Western values not strictly relevant to her study.

In conclusion, despite problems of separating positive and normative notions of an institution, the distinction between abstract and substantive approaches provides a basis on which to begin to map the concept. Abstract investigations can proceed in tandem with more substantive explorations, leading to better recognition of the many unknown features of the terrain. As we slowly determine these features, definitions may converge to an accepted view. In the interim, substantive efforts should continue to study particular behavioral assumptions and the distribution of power and authority in actual environments of choice maintaining the most general of definitions for institutions and institutional innovation. More abstract efforts using more specialized or formal definitions can simultaneously compare and analyze the general features of institutions over time and across environments.

Information and Uncertainty

Two recurrent and related themes in institutional innovation are information and its opposite: uncertainty (see Stigler, 1961). This section reviews the variety of contexts in which these themes arose. Although specific treatments varied, virtually all of the papers and discussions were concerned with information and uncertainty in one sense or another. The problem is to trace these themes and to integrate them with the specific contributions of the participants.

Weisbrod's institutional opportunity set is defined in terms of the cost of information in which the type of institution appropriate to a particular task will depend on the value attached to more certain or complete information about characteristics of institutional performance. Some characteristics such as the size of rooms in nursing homes are comparatively easy to measure with certainty while others such as "tender loving care" are not. As these measurements become increasingly difficult, the cost of acquiring this information rises. Moreover, the benefits of acquiring it may fall, leading to the notion of optimal informational efficiency for particular problems of institutional design.

The international patent system, the subject of Evenson's paper, may also be considered in terms of the flow of benefits resulting from privileged information and the comparative costs and benefits of alternative institutional arrangements. By increasing the assurance that benefits deriving from innovation will be protected, patents increase the probability that rewards will be tied to performance in much the same way as discussed by Weisbrod. As a consequence, patents provide additional incentives to draw from a "pool" of possible inventions, increasing the overall supply. In return, those granted patents must incur the cost of "enabling disclosure" in

which secrecy is removed in order to bring new inventive activity into public view. The balance between the incentive to withhold technical information and to diffuse it is thus mediated by property rights granted under patent. These rights offer some degree of protection to the patent holder in return for disclosure, extending the advantage resulting from an original position of asymmetrical technical information. New knowledge resulting from disclosure reduces this technical advantage, however, generating further incentives to increase technical leads and a resulting "race" which stimulates technical change.

This balance may be altered by the design of new patent institutions which shift the distribution of benefit streams (rents) from holders of "mainline" inventions to others who use this information to "invent around" or adapt new techniques from existing ones. Because LDC's comparative advantage lies in adaptive rather than mainline inventive activity, those who argue on social welfare grounds for increased technology transfers to these countries may seek modifications increasing foreign patent holders' duties to disclose information. LDC's can also modify the level of domestic protection granted to foreign patents, stimulating indigenous "downstream" inventive activity. Such institutional innovations may also include entirely new patents designed to protect property rights to downstream adaptive inventions.

These substantive approaches to institutional innovation are consistent with Hurwicz' more abstract description of institutional design in terms of information costs. Even if a particular system of institutions achieves well defined benefits in terms of substantive functions (such as health care or technology transfers to LDC's), the costs of operating the system may reduce its net efficiency in comparison with relevant institutional alternatives. If particular institutional alternatives are characterized by varying levels of

net informational efficiency, and if particular levels of net efficiency are well suited to particular goals, then certain institutions may match these goals better than others. Institutional alternatives can therefore be designed by reference to the criteria of informational efficiency to achieve certain goals such as health care or technology transfer. Even if they do not yet exist, institutions may be designed in the abstract to produce a conceptual shelf of alternatives which can then be related to substantive goals as needed.

This raises a question over whether the data most relevant to institutional innovation is information itself - whether the contours and relief of the institutional landscape are to be measured in terms of information units of some type. This notion is reinforced by the many anthropologists and sociologists noted by Adams who concern themselves with institutional adaptation as a response to uncertainty - the absence of information. Customs, as Barth (1981) notes, are really "frequencies of alternatives," in which a process of search for the optimal institution in a particular environment of choice describes an underlying dynamic. The particular frequency distribution describing the range of alternatives may be defined over information, as in an ordinary probability density function. The comparative advantage of particular institutions may then result from a differential capacity to deliver relevant information concerning the joint actions of others in particular choice environments. A failure to do so will result in comparative uncertainty and the incapacity to coordinate behavior. In this process, knowing the "rules" better than others implies on information asymmetry which provides the basis for superior coordination of behavior (Runge, 1982).

Since the loss of old information and the need to account for new information is one consequence of change, institutional adaptation may be described in historical terms as an evolutionary process in which groups seek continually to adapt to changing information requirements, shifting up and down a scale in response to new and the loss of old information. In this sense, institutional innovation may be described as a "search" process analogous to technical change itself (see Evenson and Kislev, 1976).

Although seemingly removed from more substantive issues, this description may relate rather directly to market failure as discussed by Kneese as well as the factors affecting national and international institutions outlined by Keohane. In Kneese's comparative treatment of water resource management institutions, negative and asymmetrical external effects create interdependence among various users, so that information concerning others' actions is relevant to the development of new property rights arrangements in the form of regional authority. New institutions such as the Ruhr Genossenshaffen or Delaware River Basin Commission express this information by assigning new rights and duties to various water users. These new public systems of rules specify certain forms of action as permissable, others as forbidden, and provide for penalties and fines when such external effects occur. Overcoming costs of organization and management in the design of these rules is thus at base a problem of information acquisition (Dahlman, 1979).

The comparative success of alternative rules may be related to the past history of the groups adopting them, indicating that the organizational basis of coordination in particular choice environments in time t is not independent of the message set in (t-1). As suggested by Reiter and Hughes' dynamic description of regulatory constraints, the changing nature of the information

set determines institutional choices over time. At any time t, the information conveyed by institutions in the previous period constitutes a prior frequency distribution with which to interpret sample information in the present (Runge, 1982). While the Ruhrverband draws on much older traditions of collective action, for example, in which voluntary contributions to public goods are expected, the failure of the Delaware River Basin may be attributed in part to the lack of a corresponding tradition by American states and firms. Such "traditions" are really information sets describing the accumulated experience of the actors, codified as "rules of thumb." In the United States, the land of the no free lunch, expectations of "free riding" may explain the propensity of government to substitute command and control over pollution for selective incentives such as fees and charges or expectations of voluntary compliance. In Texas, a different set of incentives and a well established structure of expectations, together with a basis in state law for the promulgation of water policy, may help to explain the comparative success of the Gulf Coast Waste Disposal Authority. A further distinction between state and regional water quality systems is the existence of a well-established constituency at the state level, the demands of which can be directly felt by a government with the power to respond to waste disposal needs. Regional authority in the United States never developed such a constituency. Especially after passage of the 1972 Water Quality Act Amendments, regional authorities were further weakened in their capacity to respond to such demands.

In politics, Keohane notes a corresponding set of issues concerning the interdependence of individual states and the organization of particular

institutions within states. Here too, institutions organize information by defining property rights which coordinate behavior based on past modes of organization. At the national level, not only do different traditions affect the comparative costs of alternative institutional modifications; well established constituencies with the power to block these modifications may also determine the outcome of attempts at institutional innovation. Where national traditions of collective action are expressed by "societal corporatism," institutions place comparatively greater emphasis on voluntary contributions to large organizations despite the non-exclusive and jointly supplied "publicness" of these institutions. However, in the U.S. and especially in labor relations in Great Britain (see Maitland, 1980), suspicion of national collective organization results in factionalized "distributional coalitions" in which free rider behavior by one group to the disadvantage of others appears as a dominant strategy. In these cases, because of the difficulty of achieving voluntary compliance to provide public goods, Leviathan-like responses often are proposed. Unfortunately, the costs of such institutional responses, notably their information inefficiencies, are high (Olson, 1982).

Internationally, the absence of unified interests and the power of some states to block institutional modification makes the system resistant to innovation except in crisis. This conservatism is in part a rational response of the status quo powers. In international monetary policy, for example, the benefits conferred by the currency "seigneurage" of the dollar were a direct consequence of the political and economic dominance of the United States

at the planning conferences after World War II where the rules of this game were determined. The IMF and the rules of the international monetary regime reflect a general attempt to coordinate international interactions. More recently, the resistance by the United States to calls for a "new economic order" reflects both a recognition of American advantage under current institutional arrangements and an accurate reading of the redistribution of power implied by such proposed changes in international institutions and property rights (Runge, 1977).

At both the national and international level, therefore, institutions define rights and duties in the form of rules which provide information and influence the expectations of governments and other actors, reducing uncertainty. In both cases, the supply of these institutions is affected by the existing distribution of power and traditional institutional arrangements. Both abstract and substantive approaches to institutional innovation must confront the role of these forces in determining the information set of the actors who make institutional choices.

Institutions and Technology

A principal stimulus to the study of institutional innovation is the relationship between institutional and technological change. Their interaction is important both as a background concern and as a specific focus of research. As Ruttan argues, the two types of change are highly interdependent and must be analyzed together (Binswanger and Ruttan, 1978).

The demand for both may be described in terms of relative factor prices which signal needed innovations. New income streams generated by such changes encourage further innovations in both technology and institutions, notably those affecting public sector research. The supply of such changes is generally ascribed to entrepreneurs who capture the low-cost income streams resulting from new technology. The rents resulting from such capture derive from the elimination of technology gaps and other production bottlenecks (Rosenberg, 1969). A corresponding mechanism may describe the role of institutional entrepreneurship. Here, however, classically political and sociological issues as well as broader questions of culture arise.

An important link in the supply of both institutional and technological innovation is the aforementioned issue of uncertainty. If income streams associated with new technologies are made more certain by rules which reward performance, this information may stimulate further searching for such reward. Even without raised levels of income, an incentive may exist to reduce the uncertainty surrounding existing income streams through either technological or institutional innovations. The installation of a new technology such as an irrigation pump can reduce the variance asociated with rainfed crops, which may have value even if average yields remain the same. An institutional innovation such as a users association may accomplish similar reductions in the variability of water inputs with or without a new pumping

technology. Hence, both technological and institutional entrepreneurs may be motivated not only by increases in permanent income streams but by reductions in costs associated with the transitory or fluctuating element of these streams (see Friedman, 1957; Schultz, 1964). Because institutions provide critical information concerning the actions of others, incentives exist both to innovate and to maintain institutions such as water users associations which reduce this uncertainty.

More generally, institutional entrepreneurs may respond to gaps and bottlenecks in the existing structure of rules in order to advance their own and their followers' welfare (see Frohlich, Oppenheimer and Young, 1971). These gaps and bottlenecks may be defined as information asymmetries which when corrected yield new equilibria in the demand for and supply of information itself. Since the costs and benefits of organizing particular institutional forms will not be uniform across choice environments, alternative responses will give rise to multiple outcomes (see Akerlof, 1980). As changing conditions (including technological changes) generate new gaps and bottlenecks, opportunities will arise to allay the resulting uncertainty by providing the benefits of assurance through modified or new institutional forms. However, since existing institutions involve sunk costs, and designing new ones implies transaction costs, an inertial tendency associated with the status quo may result.

The relationship between institutional entrepreneurship and uncertainty fits well with Weisbrod's theory of information asymmetries in health care, in which particular institutions appear to respond to the information requirements of the task at hand. A similar observation may be made of externality-driven institutional innovations such as the Ruhrverband and other regional water quality management efforts discussed by Kneese.

In both the health care and water quality areas, the interaction of technological and institutional innovation is important. If institutional innovation is the attempt to organize information to reduce uncertainty and coordinate action, new technology can often upset existing institutions or modifications in progress. Technical change increases asymmetries in information concerning health risks due to the emergence of new threats such as mercury poisoning in fish; these new gaps in knowledge simultaneously create disequilibria and opportunities for institutional innovations to fill them. In the environmental area, the race between technical change and regulatory response is well known, and is increasingly manifest in the demand for institutional innovations adequate to reduce the uncertainty surrounding air and water quality and toxic wastes (Runge, 1983). An important feature of this interaction, noted above, is that institutional innovations such as new health or environmental regulations must generally be compatible with the incentives of a larger set of interests (e.g., legislatures special interests, and citizens' groups) than technological innovations. This implies much higher sunk and transactions costs in institutional innovation. Since the payoff to technological entrepreneurs may be higher and easier to achieve than to institutional entrepreneurs, additional incentives prevent institutions from "catching up" with technical changes.

In their substantive historical analysis of regulation in the U.S. economy, Reiter and Hughes note that the increasingly managerial function of regulatory institutions over time raised both sunk costs associated with replacing the regulatory apparatus and transactions costs of modifying the complex organizations which make policy. Consistent with above discussions of the importance of normative issues, the changing regulatory landscape between

1880 and 1940 resulted primarily from the realignment of groups vying for redistributive gains. As these gains were realized, they promoted further entrenchment of particular organizational forms making modifications more difficult on both normative and efficiency grounds. Information, concentrated in existing bureaus, became power. Although this game of coordination was beneficial to many, the increasing inability of such large and cumbersome units efficiently to respond to rapid shifts in technology is one cause of the current crisis in regulation.

At an international level, the interaction of technical and institutional innovation is even more salient. Both Evenson's discussion of patent rights and Ruttan's work have focused on these interactions in the context of technology transfers to developing economies. The international patent system is a set of rules the purpose of which is to coordinate technology itself. Lags in the development of new patent institutions in LDC's may be traced both to technological seigneurage over patents associated with the status quo powers as well as a variety of costs to the LDC's desiring to innovate new patent institutions.

First, the sunk costs of any complex body of law, particularly in which precedent is important, are considerable. Second, transactions costs required to modify or replace the existing patent system are also high in light of the arcane and complex arguments which would need to be grasped by would be institutional entrepreneurs. Third, as Evenson notes, limitations by LDC's to the granting of intellectual property rights to foreigners may well reduce the willingness of technology sellers to deal directly with them. The net cost of

buying at least some technology might actually rise (Evenson, 1983, pp. 10-11). Hence, the overall costs of such institutional modifications or reforms are not trivial and require the organization of a well-defined constituency of LDC countries prepared to confront the power of the status quo powers.

In agricultural development, the innovation of research institutions designed to advance technical changes in agriculture faces a similar set of problems. Because it is generally easier to develop technology independent of local institutional constraints, the large agricultural research effort coordinated by CGIAR (Consultative Group on International Agricultural Research) has focused on commodity-specific research centers such as CYMMIT in Mexico and IRRI in the Philippines, devoted specifically to maize and rice technologies respectively. While important technical innovations and the attraction of technological entrepreneurs have resulted, the transfer of technology to local research institutions and in turn to farmers has been far less successful. The failure to develop constituent country interests prepared to promote and adapt these technologies is at base an institutional problem (Ruttan, 1982). Because adapting these new technologies involves organizing such constituencies, as well as major changes in the institutional arrangements of the agrarian sector of these nations, the expansion of techniques of production has outstripped the institutional capacity allowing their adoption. The high costs of group incentive compatibility associated with institutional change are thus a significant constraint to the transfer of agricultural technology.

In summary, the interaction of technological and institutional change is a general problem touching on many of the ideas of the seminar. Because improved coordination through institutional innovations may be more difficult and less rewarding than technological innovations, the information required to deal adequately with technical change is often delayed. Shortening this lag may be a primary contribution of a more systematic understanding of the supply of institutional innovation.

Conclusion - Future Directions for Research

Together the preceding sections provide a basis for further inquiry into the sources of institutional innovation. Because this inquiry is both abstract and substantive, a need for analytical as well as empirical studies exists. Abstract exercises in game theory, information theory, and hybrids such as the theory of teams have already yielded promising insights into the general nature of institutional choice. To be most useful, however, these studies must be linked more directly to empirical research - both experimental laboratory work and case studies. Here, closer attention to the alternative perspectives of different disciplines is required, as well as an attempt to develop a common vocabulary linking these disciplines to unifying abstract principles.

A central area of investigation for both abstract and substantive efforts is the role of information and uncertainty. These concepts are of sufficient generality to encompass the variety of disciplines involved, and are linked to recent analytical developments in game theory and cybernetics. Information and uncertainty may even provide the basis for a more general methodology in the social sciences, the outlines of which are only emerging (Boland, 1979).

Finally, the relationship between technological and institutional innovation provides an important backdrop to this research. By identifying the similarities and differences in the two processes, insight into both may result. In particular, a more adequate theory of the entrepreneur as both a technical and organizational "fixer" may become more apparent. This in turn may lend understanding to the puzzle over why institutional innovations seem always to lag behind technical advance. Shortening this lag may make the design and modification of institutions an enterprise of significant value in improving social welfare.

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APPENDIX A

SEMINAR AGENDA

SOURCES OF INSTITUTIONAL INNOVATION

On February 10 and 11 the American Academy of Arts and Sciences and the Technology, Institutions and Efficiency Study Group of the University of Minnesota will host a seminar on "Sources of Institutional Innovation."

An important objective of the seminar will be to develop an agenda for a more formal conference on institutional innovation. We believe that the most efficient way to move toward an agenda for the larger conference will be to devote most of our time to the discussion of substantive issues.

February 10 (Thursday)

8:45 a.m.	Welcome and announcements
9:00 a.m.	Innovation in Non-Profit Sector Institutions Burton A. Weisbrod, University of Wisconsin
10:30 a.m.	Break
10:45 a.m.	Innovation in Intellectual Property Rights Robert E. Evenson, Yale University
12:15 p.m.	Lunch
1:30 p.m.	Innovation in Environmental Institutions Allen Kneese, Resources for the Future
3:15 p.m.	Break
3:30 p.m.	Innovation in Regulation and Deregulation Jonathan Hughes and Stanley Reiter Northwestern University
5:30 p.m.	Sherry
6:15 p.m.	Dinner, Terrace Room
7:30 p.m.	Introduction and Welcome Fred Lukermann, University of Minnesota Implications for Social Science Research Robert McC. Adams, University of Chicago

February 11 (Friday)

8:45 a.m.	Implications for Political Innovation Robert Keohane, Brandeis University
9:45 a.m.	Break
10:00 a.m.	Implications for Institutional Design Leo Hurwicz, University of Minnesota
12:00 noon	Lunch
1:00 p.m.	Conference Planning Session

Robert Evenson	Robert Keohane
Allen Kneese	Leo Hurwicz
Burton Weisbrod	Robert Holt
Jonathan Hughes	Marion Rice
Stanley Reiter	Vernon Ruttan
Corinne Schelling	

APPENDIX B

STUDY GROUP SEMINARS ON TECHNOLOGY, INSTITUTIONS AND EFFICIENCY IN THE AMERICAN ECONOMY

October 1981 - May 1982

October 1	The Performance of American and Japanese Managers in Japan Robert Holloway, School of Management, University of Minnesota
	A Designers Perspective Institutional Innovation Leonid Hurwicz, Department of Economics, University of Minnesota
October 15	Incentives for Innovation in Science and Technology Theodore W. Schultz, Department of Economics, University of Chicago
	Innovation in Political Institutions Robert Holt, Department of Political Science, University of Minnesota
	Innovation in Social Institutions John Clark, Department of Sociology, University of Minnesota
November 12	Legal Systems and Social Change Carl Auerbach, Law School, University of Minnesota
January 28	Alternatives to Patents as Incentives to Innovation Frederick Scherer, Department of Economics, Northwestern University
February 11	Induced Institutional Innovation Vernon W. Ruttan, Department of Agricultural and Applied Economics, University of Minnesota
March 4	Government Intervention in Troubled Industries Margaret Dewar, Hubert H. Humphrey Institute of Public Affairs, University of Minnesota
May 6	Linkages Between Advances in Technology and Science Edward Layton, Department of Mechanical Engineering, University of Minnesota
May 27	Locational Differences in the Incidence of Entrepreneurship John Borchert, Department of Geography, University of Minnesota

October 1982 - May 1983

October 7	Models of Technology: A Comparison of Farming and Hunting Societies Stephen Gudeman, Department of Anthropology, University of Minnesota
November 11	Understanding the Productivity of Knowledge Workers Gordon Davis, School of Management, University of Minnesota
January 13	Can Public Support for Basic Research be Justified in Utilitarian Grounds John Wallace, Department of Philosophy and Graduate School, University of Minnesota
February 10 and 11	Seminar on Sources of Institutional Innovation
March 8	Industrial Disorder and Productivity: A Comparison of German and British Factories Ian Maitland, School of Management, University of Minnesota
May 17	Temperature Variations as a Potential Minnesota Resource Perry Blackshear, Department of Mechanical Engineering, and Mathew Walton, Department of Geology and Geophysics and Minnesota Geological Survey, University of Minnesota