

VERTICAL SYSTEMS ANALYSIS &
THE ORGANIZATION OF
AGRICULTURE

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"Vertical systems analysis," "a systems approach," "channel analysis"...these are terms that have gained considerable popularity in the last few years. Hardly a week passes but what a publication, course, or research effort involving one of these terms comes to my attention. The users of these terms vary widely in what they mean by "systems analysis" et al. Even within agricultural economics, several different interpretations of these terms are evident.

For this reason, I will briefly comment on the various uses of systems analysis, as I understand them, at the outset of this paper. Following this, I will appraise the applications of selected systems approaches to studying the organization of agriculture, including an analytical taxonomy of vertical systems that I have found useful. Finally, several possibilities for operationalizing a vertical systems approach will be discussed.

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The Uses and Meanings of "Systems Analysis"

In most cases, systems analysis involves an attempt to examine interacting and interdependent entities, functions, flows and forces for some defined unit or phenomenon. Systems analysis generally emphasizes both the totality and the dynamics of the phenomenon being studied. The level of aggregation and scope of the "system" analyzed varies greatly. In some cases, selected functions are examined, such as information systems, or logistics distribution systems. The level of aggregation varies from systems within a firm, to systems involving several interrelated firms, to interrelated national or international systems.

The diversity in the basic orientation of vertical systems articles and studies reflects several different ways of viewing economic systems. Those that I've seen seem to fall into one or more of the following categories:

- (1) Logistics-distribution models---these frequently employ mathematical models to determine the optimum number, size and location of entities, and/or the optimum pattern of product concentration, storage and dispersion--given existing or hypothesized production functions, employment of technology, demand characteristics, freight rates, etc. Spatial equilibrium studies, the U.S.D.A. study of the rice sub-sector,¹

¹Economic Research Service, U.S.D.A., "A Systems Model of the U. S. Rice Industry," Technical Bulletin 1453, Washington, D. C., November, 1971.

and the study by Baligh and Richartz are of this type.²

Several studies of a non-mathematical type that analyze certain commodity systems, such as dairy or broilers, also fall into this category.

- (2) Cybernetic feedback-control models---emphasize the regulating and coordinating forces and relationships in a system that produce short or intermediate term adjustments. Information flows, decision points and decision rules, and the synchronization of supply and demand forces are of particular concern. Forrester's classic study was of this type.³ The recursive programming model developed for the hog-pork sector would also fall into this category.⁴
- (3) Social and behavioral models---emphasize the social and behavioral dimensions of systems, including goals, roles, conflict, co-operation, rivalry and power--particularly as these affect inter-firm or interdepartment relationships and the coordination of the

²Baligh, Helmy H. and Richartz, Leon E., Vertical Market Structures, Allyn and Bacon, Inc., Boston, Massachusetts, 1969.

³Forrester, Jay, Industrial Dynamics, MIT Press, Cambridge, Mass., 1961.

⁴Sullivan, James and Liu, Charles, "Hog-Pork Sector Research," mimeo of presentation at workshop in systems research, MED, ERS, USDA, October 6-8, 1970.

system. The writings and studies of Stern, Mallen, Bucklin, and Palamountain are illustrative of this orientation.⁵

- (4) Coordination-adaptation models---emphasize a longer run appraisal of system coordination and adaptation. In analyzing the characteristics and dynamics of evolving systems, these studies often draw on studies of the above types, but do not lend themselves to mathematical modelling. The systems approach of the Harvard Business School (Goldberg and Arthur) is of this type with considerable emphasis on system linkages, institutions arrangements and change forces that influence coordination and adaptation.⁶

This is but one of several possible ways of classifying the various approaches to vertical systems analysis. It illustrates the substantial variation in the problems studied, the tools employed, the time periods considered, and the extent to which normative conclusions are likely from studies that may all be labeled with some type of "systems" tag.

⁵Several of these are included in Louis W. Stern, Distribution Channels: Behavioral Dimensions, Houghton Mifflin Co., Boston, 1969, or Louis P. Bucklin, ed., Vertical Marketing Systems, Scott, Foresman & Co., Glenview, Illinois, 1970.

⁶See for example, Ray A. Goldberg, Agribusiness Coordination: A Systems Approach to the Wheat, Soybean and Florida Orange Economies, Division of Research, Harvard Business School, Boston, 1968; also Henry B. Arthur, et al., Tropical Agribusiness Systems, Division of Research, Harvard Business School, 1969.

All of these approaches hold some potential for studying the organization and control of the food and fiber economy. The logistics-distribution approach has been used most widely and is appealing because of its potential for quantitative rigor and normative solutions. Some type of logistics-distribution analysis is usually required in order to employ any of the alternative approaches.

The human dimensions and the dynamic properties of vertical systems are more adequately dealt with in the last three approaches. Cybernetic models have received increased attention and can provide useful insights into coordination and adjustments over intermediate time periods. My limited understanding of recent efforts of this type, however, suggests that they encounter difficulty in adequately considering strategy, behavioral or long run adjustment factors.

The last two approaches seem to hold considerable potential in dealing with some of the critical questions surrounding the changing organization of agriculture. Past efforts of these types have largely been descriptive or theoretical in nature with relatively meager normative results or guidelines. While efforts with a social system or coordination-adaptation orientation have often lacked both conceptual and operational precision, they do provide a more comprehensive overall perspective, and some insights into interfirm relationships, system coordination and system evolution.

† The Weltanschauung one holds of the food and fiber system largely determines the questions and issues he finds of importance. The past efforts of agricultural economists have provided some highly useful results-- particularly concerning the logistics-distribution characteristics and market structure of various industries and commodity systems. I believe we can be criticized, however, for paying too little attention to vertical relationships, to the influence of market rules and institutions, to the factors affecting the evolution and reorganization of vertical systems in the long run, to the behavioral and motivational forces in systems, and to broad public welfare issues. In many cases, we have suffered from tunnel vision.

This is one of the important values of a broad vertical systems perspective. It stretches one beyond short run efficiency and logistical considerations, beyond the structure and performance of particular industries, and beyond the welfare of special interest groups. A broader, more complex view of the food and fiber economy is not without its problems however. For those of us accustomed to addressing simpler problems, a vertical systems perspective brings occasional moments of despair in trying to understand the myriad of interrelationships.

I find it useful to view vertical systems as interrelated social and economic systems in which coordination is required to effectively integrate

the functional inputs of system members; further that these systems are constantly evolving and adjusting because of pressures from horizontal competition, vertical conflict, changes in market rules or arrangements, and environmental forces. This perspective suggests a number of variables and relationships that may affect the performance of vertical systems. Because this perspective identifies coordination and adaptation as two of the key dimensions of vertical systems, a few comments about each are warranted.

Coordination

I interpret coordination as the harmonizing and synchronizing of activities to achieve some goal. In a vertical system, coordination is relied upon to integrate and synchronize the functional inputs of different system members--each of whom may have slightly divergent objectives--so that the system in total responds to market demands. Coordination is needed because of member specialization and differences in objectives; it is possible because all members of a particular system have certain interests in common. Coordination depends upon cooperation or coercion in interfirm relations.

Coordination within a vertical system is a force that leads toward systematizing, routinizing and stabilizing of member activities and relationships. It leads toward streamlined, efficient systems to satisfy short and intermediate period market demands. Such systems may, however, become

relatively rigid and inflexible in a longer run time horizon.

At any given point in time, coordination of a vertical system depends upon:

- existing institutions and arrangements (including markets and other linkages, rules and regulations, trade practices, and facilitating organizations)
- the flow of information (including its scope, accuracy and timing)
- decisions

Existing institutions and arrangements are the instruments or the vehicles through which coordination takes place. They have a strong influence on the extent to which market signals are accurately and promptly relayed to system members, and on the extent to which various members are compelled to behave in certain ways.

It may be useful to distinguish between coordination at the individual firm level, and coordination of the total commodity system. Individual firm networks may be tightly coordinated in the sense that their various functions are harmonized with the goals and strategies of the firms involved. Whether in fact the composite behavior of individual firm systems yields good coordination for the total commodity system is yet another matter. For the total system, the composite effect of the goals and strategies of many individual firms has an important bearing.

The vertical broiler system is a case in point. Tightly coordinated, compact individual firm systems have not led to more responsive resource allocation for the system in total if the stability of prices and profits are used as indicators. They have led to a more streamlined, efficient system in total, however.

These distinctions in the meanings of coordination should be kept in mind. As used in the remainder of this paper, it will be used to refer to coordination of individual firm networks.

Adaptation

Vertical systems are generally evolving systems, as opposed to steady state systems. They are continually adjusting and adapting to pressures and imbalances emanating from horizontal competition, vertical conflict, and environmental forces. This is not to suggest, however, that all vertical systems are equally responsive and adaptive. Quite clearly, history suggests that this is not so.

The factors influencing a system's adaptability are open to conjecture.

McCammon has suggested:

"...institutional change in marketing tends to be a process in which firms and channels maneuver for short-run advantage and in which they adapt almost imperceptibly to environmental disturbances."⁷

⁷McCammon, Bert C., Jr., "Alternative Explanations of Institutional Change and Channel Evolution," in The Marketing Channel: A Conceptual Viewpoint, edited by Bruce Mallen, John Wiley & Sons, New York, 1969.

Since members of established vertical systems often resist or respond only incrementally to innovations, major innovations--particularly those that threaten to restructure the system--are generally introduced by firms completely outside the system. Relatively free entry would therefore appear to be important to system adaptability.

The structure and control of the vertical system may also influence its responsiveness and adaptability. For example, although empirical data are lacking, one might hypothesize that the accuracy with which consumer preferences are transmitted (and hence the possibility that system adjustments will be relevant) improves when retail outlets are organized (so they have some power in the market place), are free of significant manufacturer control, and handle the products of several manufacturers, as compared to the opposite extreme of manufacturer owned and controlled retail outlets.

In addition, logic suggests other influences on system responsiveness, such as the presence of innovative firms at different levels in a system to set the pace for others, the growth-maturity stage of the system, the existence of government guarantees or other shields from market forces, and the balance of conflict and cooperation in the system.

Applications to the Organization of Agriculture

The foregoing summarizes some of my thoughts about vertical systems analysis. It is time now to consider the applications of this approach to the organization of agriculture.

As I indicated earlier, one of the important contributions of a vertical systems approach is in providing a more comprehensive Weltanschauung of the food and fiber economy. For example, recognizing vertical commodity systems as social as well as economic systems leads one to focus more attention on variables such as power, conflict and cooperation, and on interfirm and interagency relationships. The importance of system linkages and market rules are more apparent. The presence of parallel vertical systems is more likely to be detected. Coordination and adaptation float out as central concerns.

A systems perspective facilitates descriptive studies of commodity systems that provide considerable insight into system characteristics, behavior and performance. Ray Goldberg's studies of the wheat, soybean, and Florida orange vertical systems, for example, provide a considerable understanding of the organization, coordination and control of these systems. The careful reader can identify several organizational and control issues that might be investigated further, as well as some of the variables that might be relevant.

In conducting such a study, some type of conceptual model or classification scheme is needed. Henry Arthur has developed a taxonomy of vertical systems which I've modified slightly. It's rather simple and obvious--yet useful in breaking down vertical systems into component parts. I've found it helpful (although not completely operational) in doing a descriptive study of the vertical broiler system. The breakdown is as follows:

- (1) System purpose or objectives---while systems rarely have objectives that represent a consensus of its members, it is often useful to define the implied objectives. E.g., what does the system appear to be trying to accomplish? In instances where parallel vertical systems exist within the same commodity system (e.g., private labels and national brands), the implicit objectives of such systems are important to distinguish.
- (2) Stages of the industrialization process and the functions performed--this is simply a pragmatic identification of the "jobs to be done" and the grouping of such jobs at each stage in the value adding process. Product characteristics, spatial and temporal dimensions, and product flow channels are also included.

- (3) Proprietary and authority structure---this relates to the firms, agencies and individuals that populate the system. It is concerned with "who has control or authority over what?" Also--how is the risk distributed? The structure of the industries at each proprietary level in a system is also examined.
- (4) Coordinating and regulating institutions and arrangements---these include facilitative and restraining instruments which may be both tangible and intangible. Organized market places, trade practices, information systems, government grades and regulations, trade associations, transportation services, and credit services are some of the factors included here.
- (5) Decision anatomy---this is the network of critical decision points (and associated authority) distributed throughout the system. In addition to the location of decision points, the type of decisions (unilateral, bilateral, institutional, etc.), their time dimension (spot transaction, forward contract, etc.) and the decision environment (the forces bearing on the decision maker) are relevant considerations.

- (6) Forces and instruments of change (or inertia)---this includes the on-going dynamics of a system that lead to or impede change and adaptation. The evolution of a system and its responsiveness to external and internal pressures and developments are examined, along with the instruments or vehicles of change (new laws, university research, innovative firm, etc.).

The first and last dimensions can be thought of as the primary sources of change and adjustment. These are the pressures, the motivations, the imbalances that result in action (or inaction) by members of a vertical system. The other four dimensions, on the other hand, are the means by which such forces are translated into actions. In a very real sense, they represent the structural anatomy and the nervous system of a vertical system.

This particular taxonomy was developed as an aid to systems analysis and strategy development by firm managers, or as an analytical procedure to help understand and assess system behavior and performance from a public policy point of view. It should be recognized as strictly a classification scheme, however. It suggests neither positive nor normative relationships in and of itself.

At the present time, the lack of adequate conceptual models for the social systems and coordination-adaptation approaches to systems analysis represent definite limitations. Both are at a stage of development where

considerable work is still needed to develop hypothesized relationships, measure relevant variables, and test the relationships. Thus, to use these approaches for purposes in addition to providing a perspective and conducting descriptive studies, some pioneering work will be involved. Let me suggest one aspect of the organization of agriculture as a potential benefactor of some pioneering work.

A Social Systems Approach to Changing System Linkages and Coordination

The linkages and patterns of coordination in vertical commodity systems are undergoing both change and searching examination. This much is apparent, as contracts, joint ventures and vertical ownership are being used more widely in lieu of spot markets.

Both the reasons for and consequences of these changing linkages need greater understanding. In some cases, these are the instruments by which distribution firms have organized their vertical supply networks. The growth of motel, restaurant and retail chains, and large institutional feeders such as the airlines has resulted in a growing number of "planned" vertical systems that provide greater product control and/or greater efficiency and synchronization.

In other cases, more durable interfirm agreements have developed to redistribute risks, allow easier financing, or as a defensive move to protect investments and markets.

In comparing administrative planning and market exchange, Paul Farris has suggested that neither are inherently superior as methods of coordinating economic activity; and that "supplanting the market by entrepreneurial planning occurs at least in part because market coordination is too slow in allowing potential gains from new technological possibilities to be achieved."⁸ It may also occur to circumvent market rules and institutions that are impediments to market responsiveness and coordination (e.g., labor unions, anti-trust laws, tax laws, etc.).

From a social systems viewpoint, one of the important consequences of these linkage changes may be a shift in conflict, cooperation and power. Since contracts and joint ventures usually involve buyers and sellers in a longer run working arrangement, they appear to move a system toward greater cooperation; toward a partnership arrangement and away from an adversary vertical relationship. (This is not necessarily true. Where alternatives are limited, such agreements may be the result of market power "persuasion.")

Consider, for example, some of the agricultural cooperative—corporation partnerships that have developed in recent years. In some

⁸Farris, Paul L., "Coordination and the Competitive Market," in Symposium: Vertical Coordination in the Pork Industry, edited by Robert E. Schneidau and Lawrence Duewer, AVI Publishing Co., Westport, Conn., 1972, p. 255.

cases, these are based on cooperative ownership (National Grape Growers and Welch) or on cooperative control (Agway's involvement in the Curtis Burns-Pro-fac arrangement). However, in other cases (e.g., Heublein-Allied Grape Growers, and Minute Maid-Florida Orange Marketers) these partnerships seem to rest heavily on the expected mutual benefits from closer cooperation and coordination.⁹

What are the consequences of increased vertical cooperation? Many economists and businessmen would find such relationships somewhat suspect, feeling that sooner or later, one of the parties would capitulate or "be had" by the other.

However, if such arrangements develop because there are substantial benefits from cooperation among system members, some degree of equity and integrity might be maintained.

In his recent book, Gordon Bloom identifies several technological or organizational changes that could improve productivity in food marketing-- but which often require uniform adoption throughout the system.¹⁰

⁹See Ray Goldberg, "Profitable Partnerships: Industry and Farmer Co-ops," Harvard Business Review, March-April, 1972.

¹⁰Bloom, Gordon, Productivity in the Food Industry: Problems and Potential, MIT Press, Cambridge, Massachusetts, 1972.

Uniform product codes , for example , are necessary for the electronic checkout and computerized inventory management to realize their full potential . Bloom contends that such changes depend upon a stronger systems orientation and on increased interfirm cooperation; further that these are where the greatest opportunities for increased productivity lie rather than in increasing the efficiency within individual firms .

If in fact there are potential benefits from greater interfirm cooperation, are there also potential costs? Increased cooperation should be conducive to improved coordination, but what about system progressive-ness and adaptability? Logic suggests that as cooperation increases, conflict will decline . Can firms become too cooperative?

Bertram Gross has commented:

"Conflict among and within systems is probably the greatest source of continuing change . . . The common interests and goals that keep a system together are always embedded in a network of divergent and competing interests and goals . . . Some degree of conflict--both internal and external--is an essential stimulus to system adaptability and creativity." ¹¹

Yet, conflict may also be excessive and dysfunctional . Whether in fact this happens may depend upon the leadership and influence of those in a system that have the power to lead . Power can be coercive

¹¹Gross , Bertram, "The State of the Nation: Social Systems Accounting, " in Social Indicators , edited by Raymond Bauer, MIT Press , Cambridge, Massachusetts, 1966, pp. 176-177 .

and exploitive in a negative way; however, it can also be used to break down resistance to change, to resolve conflicts, and to stimulate greater commitment to and cooperation with a particular vertical system. Whether power and leadership in a system are responsibly used probably depends upon the orientation of those in power (LR vs SR; industry vs system), the source and permanence of their power, and the perceived benefits from "responsible" leadership.

The late Wroe Alderson suggested that a theory of cooperation is needed to compliment our theories of competition.¹² I would agree, assuming that conflict and power would be parts of such a theory. Where shifts from market coordination to administrative planning results in the foreclosure of certain markets, economic theory provides some guidelines as to the probable effect on performance. However, where markets are not foreclosed, the probable effect is open to conjecture.¹³

¹²Alderson, Wroe, Dynamic Marketing Behavior, Richard Irwin, Homewood, Illinois, 1965, pp. 37-45.

¹³Lee Preston contends that restrictive marketing arrangements may result in a larger number of firms than would otherwise exist due to higher margins and lower breakeven points. Whether the trade off of economy for greater alternatives is socially desirable depends upon the importance of each to consumers. See his "Marketing Organization and Public Policy," mimeo, State University of New York at Buffalo, May, 1972.

The interrelationships between cooperation, conflict, power, communication, competition, coordination and adaptation--if they can be discerned--could provide some guidelines to evaluate shifting patterns of coordination. For example, do contracts, joint ventures, or vertical ownership result in improved coordination? If so, is it due to increased cooperation, to improved communication, to the suppression of conflict, or to the adoption of new technology or practices? How is competition affected by changes in vertical relationships?

If conflict, cooperation, power et al. can be measured, both their interrelationships and the factors influencing them could be examined. For a social systems approach to be useful for public policy purposes, the factors that influence cooperation, conflict, etc.--and that policy makers have some control over--need to be identified.

Although I've given little thought to possible research approaches, let me throw out some possibilities. Descriptive studies of several vertical systems would be a useful starting point, including information on system members' perceptions of some of the relevant behavioral variables. These studies would hopefully identify several linkages or certain systems that warrant comparison and further examination. For example, in a system where a variety of coordinating arrangements are

used at the same stage in the system, the effect of these arrangements might be examined in depth.

In those systems where the typical linkages have recently changed, a longitudinal study might be attempted through perceived measures of behavioral factors before and after the change.

Comparisons across systems are both useful and hazardous. The behavioral dimensions of two systems with different coordinating arrangements, market rules and institutions, or market structures might be compared by using the perceptions of multiple system suppliers or members.

The experiences of vertically integrated firms in trying to coordinate different departments might provide useful insights into the role of cooperation and conflict, and the factors that influence them.

I can see some possibilities, but I also see many unanswered questions. How could coordination and adaptation be measured or evaluated, for example? Do most firm managers have sufficient interest in and knowledge about the system of which they are a part to identify the sources, location and magnitude of conflict, power, cooperation, etc.?

Developing a social systems model of vertical systems involves exploring largely virgin territory. The advances of behavioralists in addressing business problems provides some hope that such exploration would not be pure folly. For example, Stern has been reasonably successful (although success is difficult to judge) in measuring certain behavioral variables using the perceptions of system members.¹⁴ Organizational theorists have developed some useful insights into the behavioral dynamics of organizations.¹⁵

Many of our academic colleagues apparently perceive some potential from vertical systems analysis. For addressing some of the critical issues concerning the organization and control of the food and fiber economy, vertical systems conceptual models that embody social and behavioral as well as economic factors hold considerable promise. Only a few academicians are seriously struggling to develop such models. Whether we as agricultural economists want to join these explorers depends upon an assessment of the risks and pay-offs involved, and our willingness and ability to adopt a broad social science approach. Quite obviously, I think that we should.

¹⁴Rosenberg, Larry J. and Stern, Louis W., "Conflict Measurement in the Distribution Channel," Journal of Marketing Research, Nov., 1971; also Adel I. El-Ansary and Louis Stern, "Power Measurement in the Distribution Channel," Journal of Marketing Research, February, 1972.

¹⁵See for example, Richard Cyert and James March, A Behavioral Theory of the Firm, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1964.