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# The Economic Sciences and the Information Age: Lessons from the Nobel Laureates

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## ABSTRACT

Since its inception Information Systems has relied heavily on older, more established, reference disciplines for much of its theory development and practical application. The relationship between the economic sciences and information quality has been the subject of much of the work recognized through the Nobel Prize in Economic Sciences. Beginning with Simon's decision-making model published before a discipline known as Information Systems existed, this paper reviews this relationship and the parallel development of information quality and computing capability from an Information System perspective and changing paradigms in economics as recognized in the works of the Nobel laureates. From economic theories based on assumed knowledge, the paradigm is shifting to methods of empirical testing and experimentation. Organizations continue to make operational and strategic decisions. Additionally, now information is being aggregated, warehoused, mined, and analyzed to make a host of societal decisions and to understand economic behaviors through experimentation and empirical analysis.

## Keywords

Information quality, information systems, economics, Nobel laureates, decision-making, behavioral economics, experimental economics, perfect information, rationality.

## INTRODUCTION

The importance of the information base and the interpretation of it have increasingly been recognized in the realm of scientific investigation. This point, as it relates to the economic sciences, is highlighted by a series of Nobel laureates, as early as Samuelson (1970) and Simon (1978), and as recently as Akerlof, Spence, and Stiglitz (2001), Kahneman and Smith (2002) and Aumann and Schelling (2005). Assumptions of perfect information, rational self-interest in decision-making, and complete self-control have been questioned and new theoretical paradigms have emerged. The new paradigms in economics take into account movements toward assessing the validity of the assumptions themselves, incorporating research modalities from other social sciences, and reestablishing an understanding that economics is inherently a behavioral science, not merely a mechanical one. In addition, the development of the new technologies and the ability to gain insights through the use of these new technologies have changed the landscape of the knowledge base of both participants in the decision-making modeled by economists and the knowledge base that economists can tap in testing assumptions and hypotheses. This paper reviews some of the notable linkages between the disciplines of economics and information systems as both disciplines have developed since the mid-twentieth century.

Samuelson, winner of the second Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel (1970), began his Nobel Memorial Lecture with the observation that it was only recently "that economic theory has had many pretensions to being *itself* useful to the practical businessman or bureaucrat." (1970, p. 1) In elaborating he noted that "today, under the guise of operational research and managerial economics, the fanciest of our economic tools are being utilized in enterprises both public and private." (Samuelson, 1970, p. 1)

Institutionalists, early critics of the static nature of the discipline (e.g., Veblen), "share a conviction that economic theory must be reformulated to take account of the social and legal structures amidst which market transactions are carried out." (Simon, 1978, p. 351) The notion of a transaction as a basic unit of behavior, as represented in the writings of Commons, influenced both Simon and Barnard. (Simon, 1978, p. 352) Through the use of the organization theory technique of subgoal identification, analysis of decisions and the theory of decision-making progressed. Nevertheless, the classical/neoclassical economic model of rational choice assumed "complete knowledge of, or ability to compute, the consequences that will follow on each alternative... and certainty in the decision-maker's present and future evaluation of these consequences." (Simon, 1978, p. 354)

Simon lamented the inadequacies of the models derived from the omniscience assumption, both because the data were not available to individuals or organizations and because the ability to compute predictions was limited by the lack of computational power and by the lack of suitable predictive functions. As data collection and computational power improved, alternative approaches to the decision-making process emerged to further account for the failure, in practice, of the omniscience assumption. In the general rubric of bounded rationality, “elaborate organizations that human beings have constructed in the modern world to carry out the work of production and government can only be understood as machinery for coping with the limits of man’s abilities to comprehend and compute in the face of complexity and uncertainty.” (Simon, 1978, p. 354)

## EARLY VIEWS OF THE ECONOMICS OF INFORMATION

As early as 1956, Simon recognized a concept of the economics of information, and Stigler (the 1982 Nobel laureate) wrote a paper called “The Economics of Information” in 1961. Addressed in these writings were the ideas that there were limits to information and costs associated with the collection and transfer of information. However, these limits and costs were introduced into the theoretical constructs of the day as part of the technological environment, rather than as psychological or behavioral characteristics of the decision-makers. Coase was awarded the 1991 Nobel Prize for his work of more than a half century before relating to how decision-makers take into account transaction costs and the resulting organizational consequences. His characterization of transaction costs refers in large part to the cost of searching out, collecting and transferring information.

Akerlof’s (1970) “The Market for ‘Lemons’: Quality Uncertainty and the Market Mechanism” is a classic exploration of the operation of markets with asymmetric information: the complexity of information incompleteness is compounded when the incompleteness is unevenly distributed. The idea that, on an individual basis, buyers and sellers do not have the same information or the same quality of information has had significant impact on the development of theories of behavioral economics. Reporting on his first reading of Akerlof’s article, Spence (2001) commented “[t]here we all found a wonderfully clear and plausible analysis of the performance characteristics of a market with incomplete and asymmetrically located information.” (p. 407) In his 2001 Prize Lecture, Nobel Laureate Spence noted the existence of “powerful forces driving the outcomes and changing the informational structure of markets.” (p. 437) He highlights technology-related effects which interact with each other over time to produce accelerating economic effects. The focus of the technology effects is the Internet and its reduction of some kinds of transactions costs, among them the acquisition of information about buyers, sellers and products. Comparison of prices in such an environment, when sellers are willing to post prices on the Internet and buyers engage in low- or no-cost searching for the lowest price, according to Spence, increases competition. But, he admits, “there is probably more to the story.”

Indeed, Stiglitz, the third of the 2001 Nobel laureates in economic sciences, expressed the view that “Information Economics represents a fundamental change in the prevailing paradigm within economics. Problems of information are central to understanding not only market economics but also political economy...” (p. 472) For many standard neoclassical analyses, Stiglitz asserted that “the perfect information assumption was so ingrained it did not have to be explicitly stated.” (p. 483)

Prior to the late twentieth century, “economics was widely regarded as a non-experimental science that had to rely on observations of real-world economies rather than controlled laboratory experiments... But research in economics has taken off in new directions” declared The Royal Swedish Academy of Sciences (RSAS) in December of 2002 in the announcement of the Nobel Laureates in Economic Sciences for that year, Daniel Kahneman and Vernon Smith. (p. 1) The Nobel Committee recognized the work of others, including some previous Nobel Laureates in Economics, conducting experiments in economics, and specifically some important contributions to game theory, bargaining, and decision making in other market situations. But the committee held that Smith established mechanisms for conducting experiments to test traditional and other models predicting decision-making behavior. “It is largely through Smith’s achievement that many economists have come to view laboratory experiments as an essential tool.” (RSAS, 2002, p. 20)

Simon understood the difficulties in application of the unbounded rationality assumption to specific decisions as partly an expression of human behavior and partly an expression of the failure of the omniscience assumption. The motivations of humans in decision making have traditionally been assumed by economists to be self interest, self control, profit maximizing, and utility maximizing. “Human decision-making deviates in one way or another from the standard assumptions of the rationalistic paradigm in economics.” (RSAS, 2002, p. 1) Kahneman and Amos Tversky led the way in application of cognitive psychologists’ studies of human decision-making to economic problems and tests of the traditional rationality assumptions. (RSAS, 2002, p. 2) Experimental evidence indicates that certain psychological phenomena—such as bounded rationality, limited self-interest, and imperfect self-control—are important factors behind a range of market outcomes.

## THE ECONOMICS OF CONVEYING INFORMATION

As Stiglitz noted: “A simple lesson emerges: **some individuals wish to convey information; some individuals wish not to have information conveyed** (either because such information might lead others to think less well of them, or because conveying information may interfere with their ability to appropriate rents). In either case, the fact that actions convey information leads people to alter their behavior, and changes how markets function. This is why information imperfections have such profound effects.” [emphasis added] (Stiglitz, 2001, p. 496)

Economists have historically founded much of their differential treatment of the private and public sectors on differences in preference revelation. This comparison hinges on the notion that preferences are immediately made apparent in the private sector, because purchases and their associated prices are all the information necessary for revealing preferences. Here, the methodology of simple observation suffices. By contrast public sector preference revelation is less obvious since preferences are being expressed for public goods, without benefit of individual purchases directly related to prices. Here, more complex deciphering is required. However, there are instances of information inadequacies in the private sector as well. Recent events and disclosures in the corporate world have brought the issues of transparency and information quality to the fore.

A corollary to Stiglitz’ lesson might be learned from such recent scandals as ENRON and World Com: **some individuals wish to convey false information**. In these cases, we find profound examples of extreme information imperfection resulting in decisions by stockholders, employees, and consumers which might have seemed rational, but which created havoc in significant markets and in human lives. Disinformation in these cases rocked not only the private sector markets, but also the public, regulatory organizations (such as the U.S. Securities and Exchange Commission) charged with the responsibility of maintaining a level playing field in which the corporations, investors, employees and customers operate.

Another corollary lesson might be learned from the identity theft scandals, advertising ploys and gimmicks, and recent financial and health care privacy issues and legislation: **some individuals who do not wish to convey information have information conveyed and used anyway**. Identity theft has become a bigger problem in recent years due to the proliferation of telemarketing, credit card use, inventory control techniques, and Internet commerce. Advertising strategy innovations have further complicated the decision-making process for consumers due to difficulties with advertising claims, difficulties in identifying trusted sites on the Internet with which to transact business, and click-tracking, spyware, scumware, and other mechanisms for pushing unsolicited advertising to the Internet user’s desktop. So bothersome has been the potential for misuse of collected financial and medical personal information that legislation has been enacted, purporting to allow individuals to control the ways that this specialized information held by others is used.

A third corollary to Stiglitz’ lesson has to do with the quality of information conveyed: **some individuals wish to convey information, but it becomes corrupted in the process**. Because of the prevalence of use of individual data for many different purposes, including data collected at different times, under different conditions and combined in “creative” ways, it is all too likely that the resulting data set is incomplete, inaccurate, inconsistent or unstable. Decisions made by individuals or organizations utilizing this type of data are likely to be of poor quality by any standards. Data warehousing and data mining processes are not yet sophisticated enough to protect from this type of data quality problem.

## THE TECHNOLOGY IMPACT AND THE DAWN OF INFORMATION SYSTEMS

While economists were coming to grips with the issues of the perfect information/ omniscience assumption as it applied to the functioning of the market economy and the political economy, changes were occurring in technology which dramatically impacted the availability of information: computing power, data storage and access, and telecommunication. By the end of the twentieth century, Simon’s observation that predictive models for imperfect information could not be developed and tested was no longer valid. Collection and transmission of huge amounts of data had become commonplace, even if still quite imperfect. The advent of computing technologies utilizing high speed microcomputer processors and supercomputers made it reasonably possible to do the computations necessary to test a large and growing array of sophisticated mathematical models. The Internet and other data communications models became highly reliable ways to share the data in widely varied databases and to combine those databases in ways that were almost unimaginable even at the time Simon was awarded the Nobel prize.

In response to and as part of the development of the new technologies, a new academic discipline called Information Systems was spawned in the late 1970s. Out of a foundation of supporting individual transactions, data processing came to take on many new meanings. Today the information systems literature is replete with research about information quality and the effects of information on business transactions, business decisions, consumer behavior patterns, customer relationship management, and business strategy.

From its inception, information systems researchers have worked on framing the structure of information. Gorry and Scott Morton, writing in 1971, and heavily guided by Simon's writings, devised a two dimensional framework for management information systems (Table 1). One dimension included Anthony's (1965) three types of decisions: structured, semi-structured, and unstructured. The other dimension included three decision categories: operational control, management control, and strategic planning. Using Simon's (1960) phases of decision-making, a fully structured decision type would be one in which the intelligence, design, and choice phases were fully structured. Semi-structured decisions have less structured elements in at least one of these phases. Within this classic framework, uses of information and information systems—from accounts receivable and order entry to new product planning and research and development planning—were classified. (Gorry and Scott Morton, 1971, p. 74)

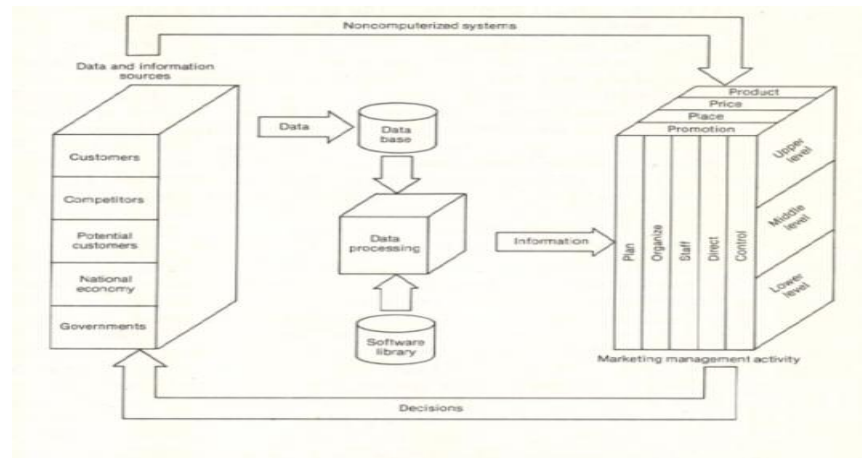
	Operational Control	Management Control	Strategic Planning
Structured	Accounts receivable	Budget analysis- Engineered cost	Tanker fleet mix
	Order Entry	Short-term Forecasting	Warehouse and factory location
	Inventory Control		
Semi-Structured	Production Scheduling	Variance analysis- Overall budget	Mergers and acquisitions
	Cash Management	Budget preparation	New product planning
	PERT/COST Systems	Sales and production	R&D planning
Unstructured			

**Table 1. Information Systems Framework**  
Source: Gorry and Scott Morton, 2001, p. 90

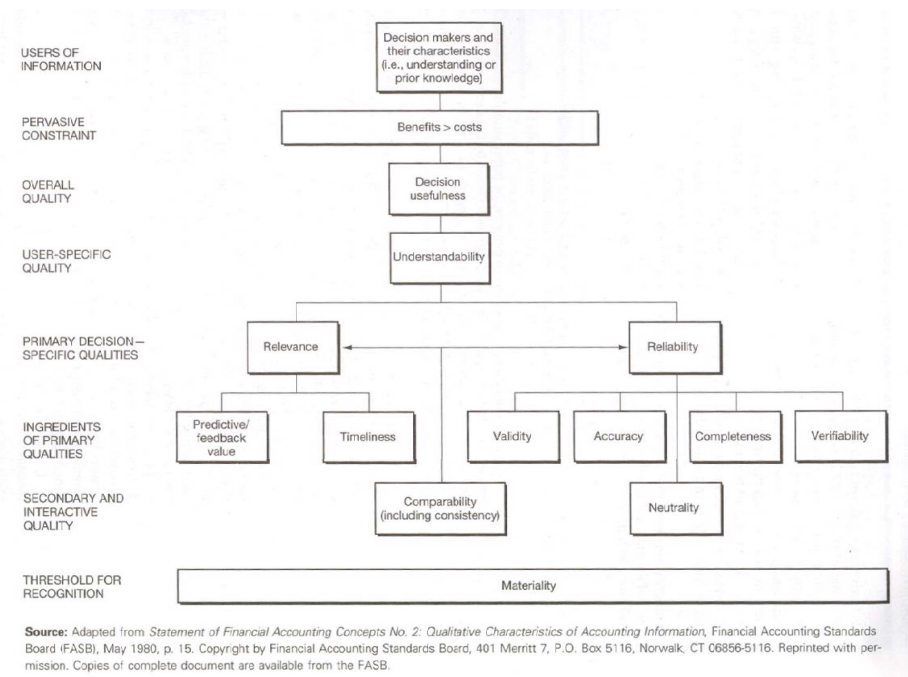
This framework has given rise to many enhancements in the understanding of the role of information in decision-making within organizations and even between organizations. Considerable academic and practitioner research is available which documents the evolution of methodologies and tools associated with the use of information within the organizational context. An example of the understanding of organizational information systems is reflected in the drawing in Figure 1, developed by McLeod and Rogers (1985) to express the relationships between various components of a marketing information system utilizing the newest technologies of the day.

Gorry and Scott Morton (1971) presented and analyzed seven characteristics of information: source, scope, level of aggregation, time horizon, currency, required accuracy, and frequency of use. Researchers at the turn of the 21<sup>st</sup> century were addressing qualities of information including effectiveness, efficiency, confidentiality, integrity, availability, compliance, reliability. (Gelinas, Sutton, & Fedorowicz, 2004, p. 17) Figure 2 depicts one interpretation of a hierarchy of information qualities, giving rise to additional clarity concerning the complexity associated with the structure of information in today's economy. (Gelinas, Sutton, & Fedorowicz, 2004, p. 18)

Noting these factors related to information quality, the complexity of information structures is further exemplified by the juxtaposition of the many extant types of databases which may be connected through networking. Viewed another way, information systems and the information they deliver interact with myriad external organizations, both sending and receiving information for many purposes, supporting economic decisions, and transactions based on those decisions. (Laudon & Laudon, 2003, p. 77) Each organizational component within the framework can have a reciprocal relationship with each other component with information flowing in each direction, and with each having the potential to compound the knowledge base by utilizing technologies associated with data warehousing and data mining. From the information systems perspective, the issues identified briefly in the corollaries to Stiglitz' lesson are central to the definition of the "moral dimensions of the information age," as graphically illustrated in Figure 3. (Laudon & Laudon, 2003, p. 143)

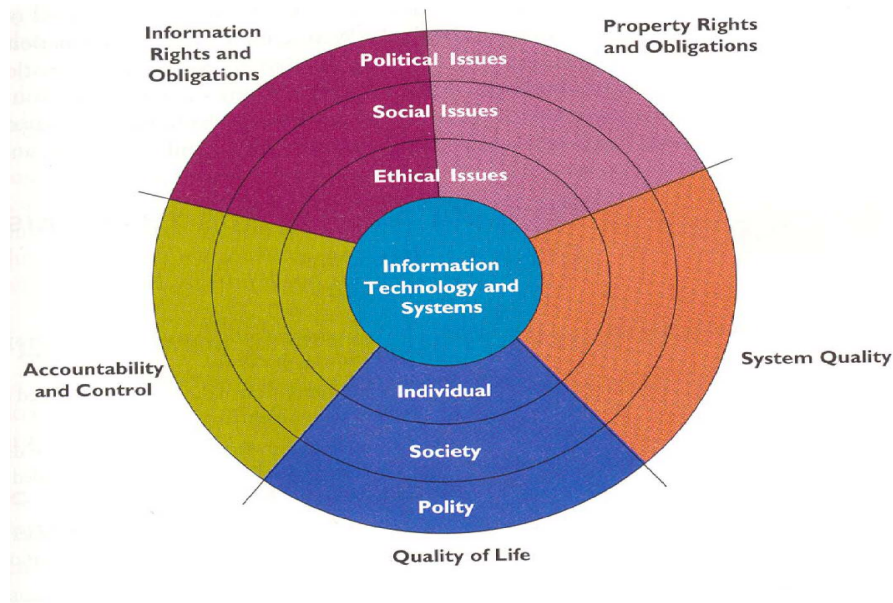


**Figure 1. Schematic Model of a Marketing Information System**  
 Source: McLeod and Rogers, 1985, p. 89

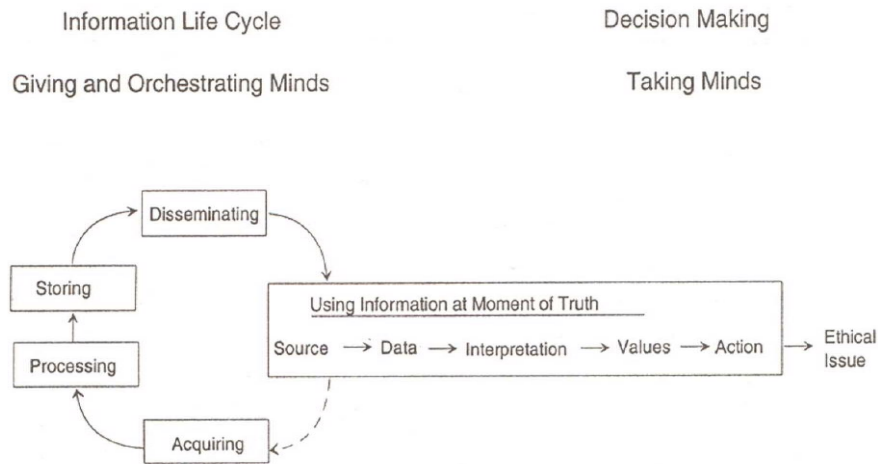


**Figure 2. Hierarchy of Information Qualities**  
 Source: Gelinis, Sutton, and Fedorowicz, 2003, p. 18.

Mason, Mason, and Culnan (1995) present the process of decision making “revolving around five key components that make up the *information value-adding chain*,” shown graphically in Figure 4. This depiction of the flow and development of information supports the concept that knowledge informs information as much as information informs knowledge. Indeed, we are no longer dependent on gaining knowledge inductively as an antidote to excessive deductiveness, but rather we can use the knowledge infrastructure through the information value-adding chain toward the acquisition of information rich, high value data.



**Figure 3. Moral Dimensions of the Information Age**  
 Source: Laudon and Laudon, 2003, p. 143.



**Figure 4. Relationship between the Information Life Cycle and Decision-making**  
 Source: Mason, Mason, and Culnan, 1995, p. 53

Internet technology and other broadcast technologies have brought the difficulties of information reliability and containability to the forefront. One has only to witness the news coverage to understand that information content is inconsistent at best and intentionally misleading at worst. This affects the quality of both public policy decisions and private sector decisions by individual consumers and private organizations.

## WHITHER ECONOMICS

There is greater discord presently in the discipline of economics, at least methodologically, than there has been for over half a century. This is explained in part by the apparent success of economics—and of the economy—during the mid-twentieth century. Of course, there were dissenters even then, including Herbert Simon, John Kenneth Galbraith, and Clarence Ayers, but a critical mass of dissent had not yet developed.

Science is inherently conservative in the sense that orthodoxy tends to be maintained until it is definitively overturned by events or empirical evidence. Measurement/data difficulties, therefore, by making heterodox hypotheses unlikely to prevail, work toward the maintenance of received doctrine. Even major critiques, if not rejected outright, tend to have relatively limited impacts as they become co-opted into mainstream thinking. Co-option rather than replacement is favored not only by the resistance of vested interests (“owners” of orthodoxy), but also because the intellectual insurgents face the burden of providing a compelling alternative story to serve as that replacement.

That a critical mass of critique has developed is now clear, a good deal of which has become incorporated into mainstream economics. Game theory, modern financial economics, and managerial economics are examples. Moreover, empirical economics is being reformulated—though the question is still open as to whether this movement is ultimately supportive of or disruptive to conventional economics.

On the one hand, it may validate theoretical structures which are admittedly constructed on overly simplistic psychological foundations if such models are found to provide accurate predictions anyway. Friedman (1953, p. 41) and Aumann (Samuelson and Barnett, 2007, p. 361), for example, believe that ultimately human behaviors tend to be patterned as if people make rational and informed decisions, even though full information and rationality are not descriptive of the decision-making process. In this view, the issue is one of the level of abstraction rather than model validity.

On the other hand, even as information systems and empirical economics are improved, movement may be away from the theoretical cores of textbook economics. Increasingly interest in such redirection is evidenced by the emergence of sub-disciplines such as “behavioral economics” and “experimental economics.”

Steven Levitt, acknowledged professionally with the John Bates Clark Medal and co-author of the best seller *Freakonomics*, contends that to understand the complex and cloudy world, “[a]ll it requires is a novel way of looking, of discerning, of measuring.” (Levitt and Dubner, 2006, p. 189)

Dan Ariely makes a similar point in favor of behavioral economics. Ariely contends that a more realistic psychological underpinning is needed not only for explanatory reasons but also for predictive reasons. His contention is not only that the predictions of conventional theory err, but that actual human behavior is “predictably irrational.” (Ariely, 2008))

The diversity of recipients of Nobel prizes in economics attests to the encompassing breadth of the current discipline, in terms of both methodology and content. The methodological range has extended from the philosophical to the theoretical to the empirical and content has ranged from games to war and peace. (Lindeck, 2007)

Colander argues that the “complexity story” of economics is in the process of displacing the “efficiency story” as the discipline’s dominant theme. (Colander, 2000) His interpretation is that this will be a displacement rather than a replacement as the conventional efficiency story will remain as a subset of the larger story of complex economic and social evolution. The degree to which the more complex story subsumes the narrower conventional story is largely dependent on empirical information and its utilization.

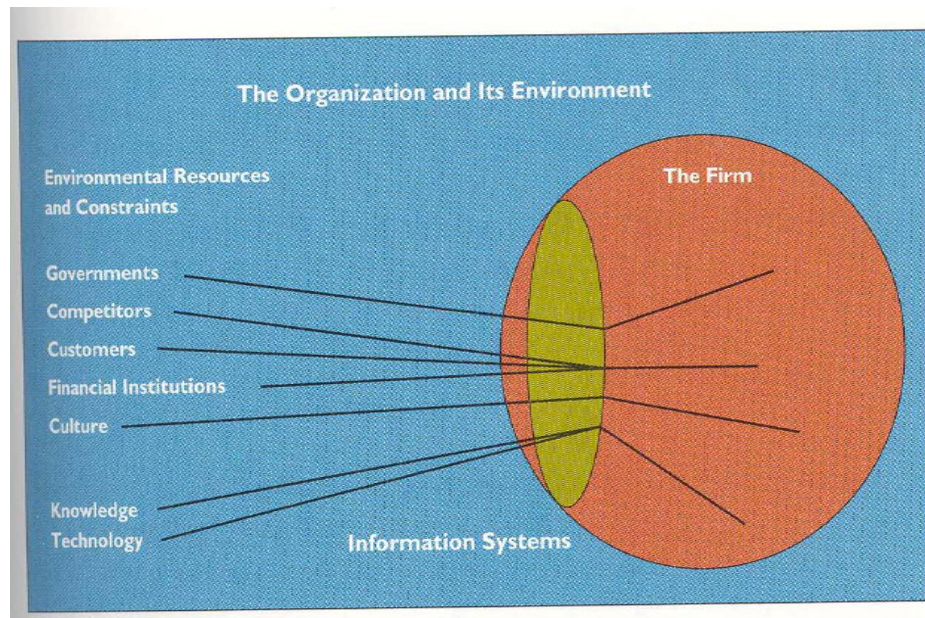
## A ROLE FOR THE INFORMATION SYSTEMS DISCIPLINE

The question “what did he know and when did he know it,” though now slightly clichéd, continues to resonate in governmental and corporate investigative settings because decisions and actions can best be judged in the context of what the decision-maker *knew* at the time. Decision quality is driven by both knowledge and information. Knowledge suggests that good decisions can be expected if good information is available—i.e., it provides a framework for understanding and decision-making but is still dependent on the information foundation available. It behooves economists to understand and further refine the theory of economic activity in terms of human behaviors. This requires utilization of the vast quantities of information available, the amazing computing power possible, and the phenomenal communications capabilities available to the end that social goals are more attainable, public policy is more successful, and high quality corporate and individual decisions are possible. It also requires avoidance of disinformation and obfuscating—rather than enlightening—analytical structures. The question from the Information Systems perspective involves persistent attention to issues beyond those of a single organization and purpose for publicly or broadly available information (Figure 5). While management of the information resource of organizations is and will continue to be critical operationally and strategically, new technologies and



new paradigms in economics require reframing the scope of the Information Systems discipline well beyond the organizational level.

Further research into linkages available to the two disciplines will involve a meta-analysis of research associated with special interest groups and newer specialized academic conferences related to very large databases, information quality, data warehousing, and data mining. An analysis of communications, notes, and algorithm development presentations should provide a platform for understanding the differences between research for decision-making within organizations and the broader decision-making associated with the theoretical constructs embodied in the economic sciences. This further research should lead to the creation of a new framework of decision-making structures patterned after the IS framework of Gorry and Scott Morton. A new taxonomy of economic decision-making should provide a useful bridge between the economic sciences and information quality theory and practice. The new framework and taxonomy should incorporate the methodologies, technologies, and theoretical constructs presently available, including in particular those highlighted in the writings of the Nobel Laureates referenced herein.



**Figure 5. Information Flows from the Perspective of the Organization**  
Source: Laudon and Laudon, 2003, p. 77.

Decision quality is limited both by analytical capacity and information quality. At present, even for the theoretical, deductive maximizer, information efficiently limits decision-makers to satisficing. Improvements in information systems and quality, therefore, will promote movement at least in the direction of truer (less bounded) maximization and at most in the direction of theory reconstruction. "With all these qualifications and reservations, we do understand today many of the mechanisms of rational choice. We do know how the information processing system called Man, faced with complexity beyond his ken, uses his information processing capacities to seek out alternatives, to calculate consequences, to resolve uncertainties, and thereby – sometimes, not always – to find ways of action that are sufficient unto the day, that satisfice." (Simon, 1978, p. 368)

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