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INFORMATION TECHNOLOGY, INFORMATION SYSTEMS AND INFORMATION UTILITY

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ABSTRACT

To resolve the modern information problems many types of information systems evolved with corresponding uses of information technology. However, from many user reactions it seems that the user's problem in getting relevant information has not been significantly alleviated and even worse, it seems that many solutions based in the new information technology resulted in new barriers, imposing new levels of complexity and difficulty for the user. A reorientation of information systems toward users seems to be in order. One approach is to consider information systems as a utility type of enterprise. Utilities may provide a conceptual framework around which some information systems may be organized and some information problems may be alleviated.

This paper is derived from a study named Project INFUT (INFormation UTility) which is attempting to uncover conditions under which a wide variety of information sources and systems could be considered as a utility. The following areas are discussed in detail:

... the characteristics and properties of public utilities from which we can start discussing characteristics and properties of information utilities.

... the properties of information and information systems that will affect the development of information utilities.

... the properties of technology in general and information technology in particular that should be taken into account in the development of information utilities.

... the attempts to specify properties of information utilities.

INFORMATION TECHNOLOGY, INFORMATION SYSTEMS AND INFORMATION UTILITY

1. IMPORTANCE OF INFORMATION

Information is vital to the functioning of individuals as well as society. Although information is, along with energy and matter, a most elementary, indefinable notion, we fundamentally connect the notion of information with order and structure and conversely absence of information with disorder. In nature, the differences in quantity and quality of information make essential differences among organisms and even characterize the essential difference between living and non-living entities. To societies, (as concluded in numerous investigations including UNISIST reports) one of the fundamental aspect characterizing the degree of development of a population is the quality of the information available to its members (individually or in groups) when confronted with problems. In turn, the degree of quality of life of a population is characterized by the wisdom in use of that information by its members in making decisions about problems.

2. THE NATURE OF INFORMATION

Serious information problem exist in obtaining the right information in needed amounts at the correct time. This is a world wide phenomenon transgressing political and economic systems, geographic boundaries and stages of development. Too much information is as detrimental as too little information.

The nature of modern information problems can be perceived as a quantity/quality paradox: overabundance of information at the source ("information explosion") and scarcity of relevant information for the user at the destination. In an attempt to resolve these problems, many types

mation problems allevaited. A number of proposals to this effect have been made (e.g.2).

In summary, the recommendation for considering information systems as information utilities rests on two primary expectations. First, on the level of psychological impact, the concepts of a utility (or public service) type of enterprise evokes a positive response because it is associated with the elusive but important idea of operating for public good--it is hoped that this will become the major orientation of information utilities as well. Second, on the level of performance, the particular enterprises which are recognized as public utilities indeed were quite successful in dealing with problems of regulated supply of commodities or services with unique characteristics--it is hoped that information utilities will achieve a similar success in performance.

3. PROPERTIES OF UTILITY AND PUBLIC UTILITIES

The word Utility refers to two related but still distinct concepts: (i) the state or quality of being useful, and (ii) the capacity to satisfy human wants or desires. Intuitively, we consider an enterprise to be utility when it exists primarily for the public good (whatever that elusive, ethical concept may denote). Ideally, as individuals we would like to avail ourselves of the service provided by a utility when convenient to us and use the service for our purpose and in our own way relatively independent of the utility. Services should be provided to the user in sufficient quantity and quality to satisfy his needs. The public utility (or as in many countries called public service) as a distinct type of enterprise, evolved over centuries as a result of the public desire for feasible and useful services (or commodities) that individuals organized in a society did not have a capacity to provide for themselves. This type of economic institution exhibited one distinctive aspect: the nature of the service was such that it required specific regulation to exist and satisfy all of its users; an equalitarian principle of service became the base for regulation.

The many facets of public utilities are illustrated by the number of fields in which utilities are a subject of study: fields such as economics, sociology, jurisprudence, engineering, political science, ethics, management, etc. Throughout the world public utilities are subject of laws; remarkably the concerns of laws are similar regardless of the political or economic system in whcih the utilities occur. Thus, general properties of public utilities exist across geographical boundaries.

Public utilities provide services in at least these general areas:

(a) provision of energy (electricity, gas, etc.);

(b) provision of water;

(c) transportation of people and goods (common carriers);

(d) communication (telephone, radio, transmission of signals, etc.);

(e) provision of environmental services (sanitation, conservation,etc.).

The dividing line between a business and a utility as a fuzzy one indeed. The really interesting part of this fuzzy line is that it exists at all. Suppose we view the economic relations between producers (or providers) of services or commodities and consumers (or users), as a continuum from 'private' to 'public'. This is not a consideration related to ownership of an enterprise. At this point it is immaterial who is the owner. What is under consideration is the amount of control or regulation and the degree of independence. Consider the end points as ideal. On the 'private' end, we have the arrangements made directly between a provider and a user; interactions, effects and benefits are directly dependent upon any or all individuals involved.

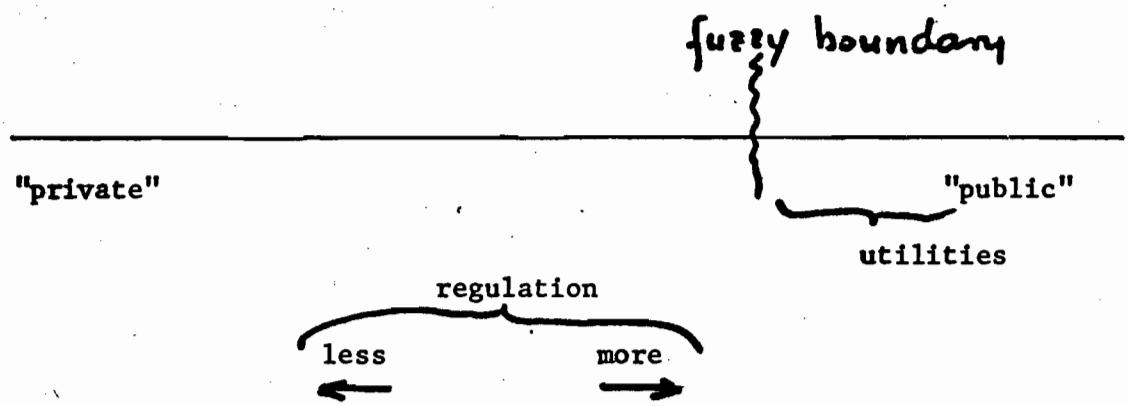

Figure 1: Continuum of Relations between Producers and Consumers in Regulation of an Enterprise

Moving away from the 'private' end of the continuum, the relation becomes more complex and indirect and governed by forces of supply and demand, open market, planning, or the like. The actions of some individuals still affect the welfare of a great number of others. Usually the benefit an individual obtains from the service or commodity is dependent on the degree of his direct contribution ot tis provision. At the 'public' end the main governing force is public regulation. Control is exercised so that individual actions should minimally affect the welfare of others. Here the benefit to the individual is relatively independent of his contribution. Between the two extremes are clusters of enterprises that relate in various ways the sources and users of (maybe scarce) services or commodities. Public utilities are that cluster of enterprises that have moved or are moving, more than other economic enterprises, toward the 'public' end of the continuum.

As public utilities moved along the continuum they became characterized by a certain set of properites (3). All possess these to a greater or lessor extent.

1. Monopoly: a public utility enjoys a territorial monopoly because of a necessity for large capital investments and public inconvenience due to repetition of facilities or other capital items which would result if there were any significant direct competition. But competition is still possible. Such competition exists between utilities with generally similar end uses

(e.g., a user's choice between gas and electricity to heat water). Competition exists between spending for a utility and any other spending (e.g., choice between buying an electric appliance or, say, buying the carpeting).

2. Social responsibility and licensing: an enterprise becomes a public utility by virtue of a territorial license from some public body. The license carries the obligation to serve an entire body (usually the encompassed population) under reasonable conditions.

3. Franchise: along with license, the public (i.e. public body) provides a utility with some rights without which the service would not be possible (e.g., right of passage, air space, etc.). Therefore the public gives up something.*

4. Economic regulation: a third party regulates the price of service and is entrusted with prevention of abuses generally associated with monopoly situations.

5. Service regulation: third parties regulate the standards of service and the provision of facilities and insure that the utility meets its social responsibilities.

6. Users and utilization: the users of public utilities also have a certain regulated responsibility toward the utility, among others, in the way the service used. There is an effort in user education. The concept of utility involves a equalitarian use, therefore the distribution of users of a utility involves few heavy users at the top falling monotomically to many small users. There is no utility, nor there can be, without this large "tail" of users each of which uses the utility a little, but all together they amount to very much.

Enterprises that desire or are forced to assume the role of a public utility have to some degree all of the above properties. They may also have to develop methods and strategies necessary for fulfilling these properties.

The previous discussion has presented the properties of public utilities. These utilities all have one thing in common; they are the basic stuff of every-day living in a large organized and complex society. As individuals we may need many additional things to function and survive,

*License is the responsibility and franchise is the means by which the responsibility can be carried out.

however, as integral members of modern and large social groups we also need the essential services of utilities which have become an integral part of life. The integration in everyday life of people in a society that reached a certain level of development and complexity is the basic, common nature of services or commodities provided by public utilities. Because of this it appears that many aspects of utilities are fundamentally the sam across national and political boundaries in most societies that have reached a certain level of urbanization. As the complexity and development of a society increases, we can expect that utilities will play an even larger, more important, role. We can expect that a number of enterprises previously not considered as utilities will assume properties of utilities, and that entirely new utilities will be developed to deal not only with functioning of life but more and more with the quality of life in a society. Information utilities may be one of these.

4. INFORMATION AND INFORMATION SYSTEMS

Prior to considering properties of information systems as utilities, some general aspects of the underlying phenomenon and related process and systems, namely, information, communication and information systems need to be considered. The nature of these underlying phenomena affect the specific characteristics of such a utility.

Communication is a process where something called information is transmitted from one entity to another. The first enitity is usually called source; the second the destination. In addition to simple transmission, there can be a dynamic exchange and feedback between them. The entities can be people, organisms, inaminate objects , or machines. The concerns and problems in a communication processes can be divided into different aspects or levels. These levels are technical or engineering problems, semantic or language problems and behavioral, effectiveness or relevance problems.

Relevance then can be defined as a measure of the effectiveness of the contact between a source and a destination in the communication process. Finally, systems that conduct communication processes are called information systems.

As a fundamental phenomenon, it is not known exactly what information is, any more than we know what is energy, gravity, and so on. But we can objectively study the manifestations, behavior and effects of information and properties of information systems. Let us begin from an intuitive understanding.

People have a strong intuitive understanding of information. They can and do use information with or without a formal understanding (e.g., Spinoza: "In order to know, there is no need to knwo that we know, much less to know that we know that we know") Therefore, it is with this everyday understanding of information that the vast majority of users approach information systems. They make requirements upon information systems within their framework of understanding of information and not necessarily the systems framework. In this respect information utilties may differ from other types of utilities. This work suggests that an information system will have to be primarily oriented toward the intuitive understanding of information by its users in order to become a utility. The complexity of this order is great because the intuitive understanding of information involves a tremendous variety of manifestations and relations such as:

...At the broadest level the understanding of information involves the notion of knowledge. That is, there is some content something new, something previously unknown.

...Next, it involves entities. There exists somebody or something that wants or needs it and sombody or something that contains, possesses or holds it.

...There exist a variety of possible processes, e.g: transmitting, providing, uncovering, observing, deducing, etc.

...Information may be found in a variety of possible forms, such as, facts, data, messages, statements.

...In a variety of physical manifestations; e.g. signals, media

...And above all and all the time, it is implied that information has some eventual use above and beyond information itself. That is, there is some purpose--to act, to decide, to enhance or control other processes, to make money, to survive, to change or add to what we know, or even to enjoy or aesthetically appreciate.

In a formal vein the phenomenon of information is studied in many diverse disciplines and so confirms the complex ramifications and many manifestations associated with it. Intrinisically, and integrally involved with information is the phenomenon of knowledge (4,5). In dealing with the phenomena of information and knowledge an important point made by Russell should be considered: That a definition of knowledge (and information) involves a certain inevitable vagueness and inexactitude (6). Consequently, one expects and must adapt to a certain inevitable vagueness and inexactitude in any information system. Thus, in any inf mation utility (with the possible exception of information utilities that exclusively deal with transmission of signals) we have to expect vaguenesses and inexactitudes in their service. This may be one of the unique properties that an information utility does not share with other types of public utilities and eventually may prevent evolution and design of information systems into utilities in a manner comparable to public utilities.

Information systems are in integrated assembly of many diverse elements which may be classified and described in a number of ways. This is one way: isolated elements of information systems may exhibit physical, biological, psychological and/or sociological properties (however, it should be recognized that the system as a whole, because of interactions, may be different than any properties of its elements). These properties are elaborated in the list that follows.

(a) Physical properties: involve among others, the physical nature

of signals, symbols or patterns used in representing information in a system (electromagnetic, chemical, optical, etc.); the form and distribution of these signals, symbols or patterns (7,8); the physical media in which they are recorded; interestingly, it is through these physical aspects that we usually associate information and energy (9).

(b) Biological properties: involve structure and processes of the brain and nervous system and effects of these on the structure and limitations of other man-built information systems (10); derived from biological structures are information properties of systems such as redundancy, association, ordering, and quasimetric relations (11); it is through the biological aspects that we associate knowledge and life--"life is a knowledge process" (12).

(c) Psychological properties: involve states in individuals that enable us to perceive and refer to entities other than ourselves; ability of learning (i.e. ability to acquire, store, associate, modify, recall and apply knowledge); the property of compatibility between knowledge states; and storage as a prerequisite for communication.

(d) Sociological properties: involve the context of the social environment in creation, distribution and use; language; behavior of public knowledge (e.g., distribution of creators (Lotka's law) and of records (Bradford's law), cumulation, obsolescence, etc. (13); epidemic interactions (14)

Finally, the properties of information systems as a whole must be considered. A system is formed by combining individual elements with above properties. Once combined, these elements interact to produce an information system with a unique set of properties. These include (a) redundancy of information, (b) association between elements of information (classification), (c) ordering of elements of information, and (d) the existence of quasimetric relations between elements of information. Without these properties there is no information system (or one that cannot function effectively and hence will not exist for any extended length of time). The crucial problems are these: How can we add properties of a utility to these properties of information systems? How do the properties of an information system change when the additional constraints of a utility are incorporated? Which types of information systems can become informa-

tion utilities?

In summary, consideration of information systems as utilities are affected by:

(a) Intuitive understanding of information by its users.

(b) Inevitable vagueness and inexactitude associated with the phenomena of information and knowledge.

(c) Diverse combination of properties and interactions exhibited by elements in information systems. These diverse combination provide for diversity in types of information systems. Some types of information systems may be more suitable of becoming a utility than others.

5. INFORMATION TECHNOLOGY

As mentioned the concept of utility (or public service) evolved in response to needs of complex societies. In the physical realization and operation of utilities technology played a dominant role. We suggest that information technology will play a dominant role in development of a wide array of information utilities. It already did so in the development of the so far only truly widely existing information utility, the telephone companies. Therefore, consideration of technology in general, and information technology in particular can be useful (if not even indispensible) in considerations of information utilities.

First, let us consider the generic and implied meanings. Depending on the context, user and usage the word technology has many connotations always continuum of integrally related meanings, where the suceeding meanings encompass the previous ones. On the narrow end of the continuum technology refers just to machines or even tools (in information technology this means computers, transmission equipment, printing press, reprographic equipment etc). Next by technology we may also mean the procedures, rules, standards and norms related to the application of

machines (e.g. software, standards of operations). On the still broader level by technology we may also imply the processes carried out (e.g. computing, retrieval). Further, we may also imply the people creating and/or running the machinery or providing for procedures and processes (engineers, computer operators, information specialists, system analysts etc). These four encompass the most customary connotations of the word technology, however, a times two still broader connotations are present: (i) the array of operations, businesses, systems, industries that in some way create or utilize machinery and (ii) on the broadest level, a type of a social system-- technocracy. When discussing information technology in the widest sense all these apsects may be and have to encompassed, however, we may limit ourselves to narrow meanings when considering particular applications.

Second, let us consider some basic relations and effects common to all technologies. These aspects assumed a stature of empirical "laws" and have to be taken into account when considering information technology in any context and especially in the utility context:

1. Developments in technology enormously affect human life and human social, psychological and possibly even biological evolution and vice versa. Not considering people first is the most common vice in applications of information technology which eventually leads to utopian systems(15).

2. Technology can be used for good or bad, wisely or stupidly, constructively or destinctively--thus in use of information technology enter considerations of ethics, of norms and values of life and of ecology of communication.

3. Creations and applications of technology are based on knowledge, art, and trial and error--use of information technology has to be based on solid research and knowledge of problems to which applied otherwise the maxim computers are costliest way to make errors holds true.

4. Technology involves economic cost and (positive or negative) economic benefits. Information technology costs enormously and does not provide any direct savings ever over budgets where it is not used. However, information technology provides for doing things that we couldn't do before, either in some quantity or even quality--but there were many instances where this was not so. Economic benefits of information are hard if not impossible to measure, thus justification is hard.if not impossible to measure, thus justification is hard.

5. Technology involves investment and policy. Modern information technology involves large investments requiring policies on a broad level, even national or international. Wide array of information utilities will have its beginning by policy decisions outside of information systems themselves. The most common mistake in investment policy of information technology is that disproportionate amount is invested in machines and very little or even nothing in people, their education, training and their time to study the problem. (This is the main reason why generally we have an incredible number of incompetent computer people because they either know little about (a)computers, (b) problems to which computers are applied or (c) both.)

6. Historically, technology is capable of being diffused across any and all social structures and political, economic, or geographic barriers. Once concepts of information utilities are formulated, information technology will be instrumental in diffusion of the concepts. Diffusion of innovations is best promoted through some or ther form of personal contact.

Third let us consider the relation between types of information technology and the concept of information utility. Generically, there are three types of information technologies classified by jobs they do:

a) printing, reproduction, reprography

b) telecommunication

c) computing and similar logical processes

A separate technology developed for each of these jobs. The current and comming revolution in information technology lies in the marriage between any and all of the three separate technologies e.g. on line

computer terminals at long distance, computer typesetting, computer and microfilm, reprography at long distance, etc. It is entirely possible that a wide array of information utilities may primarily evolve from and around these marriages of different information technologies.

Fourth, to consider two aspects which favor development of information utilities. Along side the evolution and spread of computers a considerable number of computerized data bases became available commerically or in some similar fashion (e.g. through governments). The use of these data bases are pretty much left to users, as are for instance libraries or handbooks. Furthermore, software packages, instructional systems and the like became also generally available to be for problem solving by users directly. Again the utility concepts are particularly suitable for these uses, as a matter of fact, there can hardly be any widespread and equalitarian use of these data banks and software packages without instituting them as utilities.

Finally, let us turn to a prerequisite for the speed of spread of new technology. Historically, it was shown that information technology is received fastest where good information systems exist already (e.g. spread of printing). Good libraries are one prerequisite for a fast spread of computerized information systems. Therefore, in application of information technology it seems logical to devote attention to information systems that do not directly use that technology, otherwise dangerous vacuums do happen. We may expect that a similar connection is also true: information utilities may evolve fastest where good information systems exist already and where good applications of information technology were realized. (This does not deny that: (a) information utilities could evolve in parallel with evolution of new information systems and new information

technology and (b) information technology in some information utilities will not be used directly by users, but it will help reorient the systems toward a utility e.g. library automation, mass reprography,).

The topic of information technology should not be left without mentioning a most improtant historic lesson: information technology, especially the modern one, can and does play a dehumanizing role. There are very few attempts to avoid this and we may pay dearly if we continue this. Utility concepts may help in humanizing applications of information technology.

6. TOWARD SPECIFICATION OF PROPERTIES OF INFORMATION UTILITIES

Information systems, such as libraries, were a part of human civilization almost since its beginning. There is no civilization without formal information systems to cumulate, preserve, and disseminate recorded knowledge. The great number of types of information systems that have evolved are due to a number of factors. Different environments required development of different systems that utilize different combinations of properties. The variety of uses of information and its purposes effected the development of different systems for their different uses. The development of various techniques and tools for use in information systems resulted in different systems for the same manifestations and uses. A variety of economic constraints imposed upon systems forced development of systems within these constraints.

Eventually, we must investigate what types of information systems can be institued as information utilities. In many countries some information systems already have fully assume operations as a public utility. These systems are characterized by predominance of elements exhibiting physical properties and oriented toward technical aspects of communication: they transmit signals, (e.g. telephone companies and common carrier of com-

puter, TV, and signals). In addition, there are some other types of information systems that are operating partially as public utilities. These systems are characterized by the predominance of elements exhibiting psychological properties. Certain types of education systems, such as educational laboratories, are used as if they were utilities.

As present, conditions in highly developed countries may be such that there is a need for more information systems to assume operations as a utility so that they can function without perturbations that high development introduces. Also, conditions in many less developed countries may be such that there is a need to institute many existing as well as many new information systems as information utilities in order to speed up diffusion of knowledge and in this way contribute to the speed up of the development. This is particularly the case with systems containing a predominance of elements exhibiting sociological properties. To be more specific, certain classes of libraries, information retrieval systems, information analysis center, public information systems, management, financial and business information systems, control and decision systems, transportation information systems, inventory systems, health information systems, government information systems, along with a certain class of education systems, should move toward becoming an enterprise similar to a public utility. They should become an information utility.

At the end let us turn to some preliminary observations from the various studies in Project INFUT in answer to the following question: to what extent are the properties of public utilities applicable to information sources and systems in a university environment, in general and the environment provided by Case Western Reserve University as a private university in particular?

(a) Monopoly:

Various information systems in the university do have a monpoly on particular types and/or form of information for their users. In a university environment there are actually a number of information systems that eventually could be considered as information utilities. Each is relatively independent of the other. In this respect there is a strong parallel to public utilities in a city. There exists direct competition of information systems and sources in a university for funds not users. Also, a great amount of redundancy of information exists due to the relatively independent informal sources (private holdings, invisible colleges). These sources are not a utility; however, they supplement and/or replace at times the formal sources such as libraries and curriculum. As an aside it could be noted that, in this respect, there is strong parallel to the situation with transportation utilities. The basis for distinction between formal and informal sources is the fact that policy for access for the former is determined by a management and the latter by the individual source itself.

(b) Social responsibility and licensing:

Licensing of different information systems exists but it is of an informal nature. Some formal licenses are issued by administration and/or faculty government bodies such as the approval of specific curricula or the specification of the role and users of computer complexes, and so on. In the particular situation of a private university, the outside influences on licensing are minimal. Most licenses are due to long tradition of the academia. Interestingly, newer information systems and sources (lacking an understanding of their role ususally governed by tradition) are in constant transition and are formally licensed more than the older systems. The social responsibility of information systems is well understood by the professionals in the field and by users. However, as an public utilities, these two understandings (by the enterprise and by the public) may not coincide.

(c) Franchise:

This is the least understood property of an information system as a utility. Licensing is a charge to do something; franchise is giving something so that the license can be carried out. As an example, to a telephone company we give a right of passage over public or private land and more subtly and individually, we give up to some extent our right to privacy. But what must we give to (or give up for) information utilities? Certainly space and funds. But there is perhaps more. Finding this should shed quite a bit of light on the validity of the utility concepts.

(d) Economic regulation:

In a private university there is no pricing of services by

third independent parties as found in public utilities (in public universities there often is). However, there is a strong system of regulations in allocation of funds and resources by the management, i.e. management assumes the role of an economic regulating agency. In general, there are no, and perhaps never will be, economic units as found in public utilities suitable for pricing and thus direct economic regulation. Therefore, it is expected that information utilities may never be directly economically regulated. The economics of information is the second least-understood property of an information utility.

(e) Service regulation:

There is a minimum of direct service regulation (including prescription of standards) of information services by third parties as found in public utilities. In public universities, the attempts to regulate service by third parites are more prevalent and on the increase. However, there is need of strong regulation of the condition of service as a part of any given information system. The management and the professionals in the systems presently act as a service regulatory agency. As in public uitlities the evaluation of quality(as opposed to conditions) of service is rather elusive and not formally understood or pursued.

(f) Users and utilization:

In the distribution of the use, information sources and systems in a university strongly parallel the uses of public utilities, However, the information systems are not really organized according to users problems, needs, or usage patterns. This sometimes results in user frustration. For instance, the curriculum is organized according to traditional departmental lines and the subjects -- students more and more are not; libraries are organized independent of the departmental or subject organization; computer facilities are organized around the computer; etc.

In summary, some information sources and systems in our university have some hallmarks of a public utility, but it would be stretching it very much to say that any of them as presently organized is indeed a utility. To be operated as a utility there is a need for:

(a) a significant reorientation toward use and users

(b) a significant reorientation in the approach to cost and economics of information

(c) a much more specific structure of economic and service regulation

(d) instilling in users the feeling of responsibilities and relationships similar to those they have toward public utilities--and this may be the hardest ot achieve.

7. CONCLUDING REMARKS

Calling information systems information utilities will not make them into any type of a utility. Nothing short of a positive difference in the service to users can make them into a utility. Some general framework is needed with in which this difference can be achieved. Basically, in this paper we speculated about the bare essentials of a conceptual framework around which information systems can be operated as information utilities. However, much work remains to be done to complete the framework. We need furhter work to determine what types of information systems are and what types are not suitable to be operated as a utility; clarifying what properties of public utilities are absolutely necessary for an information utility; clarifying what properties are to be unique to an information utility clarifying the role of information technology in relation to information utilities and finally, determining what strategies are needed for achieving these properties.

There is nothing that an information system can do when it is formulated as a utility that it could not do under some other formulation. What the utility idea does, however, is vastly important, for it allows the structuring of the system in a unified and consistent manner. It is this aspect that should advance the understanding of how information systems could be organized for vast improvements and at the same time point the way to how this organization can be realized in actuality.

REFERENCES

1. Project INFUT (INFormation UTility) supported by the National Science Foundation, Office for Science Information Services, Grant No. GN-36085, conducted within the Complex Systems Institute, Case Western Reserve University; William Goffman, principal investigator, Douglas Rothenberg, Tefko Saracevic, Paul Stephan, principals. Duration: Oct. 1972-Oct. 1974. Major aim of INFUT is to investigate conditions under which a wide array of information systems could be considered as a utility (or public service) type of enterprise.

2. Slamecka, V. and P. Zunde. "Science and Information: Some Implications for the Education of Scientists." The Proceedings of the International Conference on Training for Information Work. F.I.D. publ. 486, Rome, 1972, pp. 357-370.

3. Kahn, A.E. The Economics of Regulation: Principles and Institutions. 2 vols. N.Y., Wiley, 1970, 1971.

4. Pears, D. What is Knowledge. N.Y., Harper, 1971, 106p.

5. The point was often made that 'information' cannot be treated only in statistical terms and that for most practical purposes 'information' and 'knowledge' are so integrally related that they are nearly synonymous. (e.g. for a passionate argument of this point see essay by Lorenz in reference #15). We accept that 'knowledge' is a state, a notion, a concept--a phenomenon that can neither be measured nor precisely defined. Characteristics and manifestations of knowledge include: perception; search and creation; rationalization; organization, systematization, accumulation, and obsolescence; association, redundancy, feedback; language, representation and records; transmission, teaching and learning; uses and problem solving; environment, culture and society. We can observe that these manifestations can be grouped into two broad classes: those that refer to the "holding" in the minds of individuals and those that refer to communication from mind to mind. It is within the context of these latter communication related manifestations of knowledge that the notion of information is brought in and related to knowledge. We may view 'knowledge' in a static and 'information' in a dynamic sense--knowledge may be compared to potential energy and information to kinetic energy. In that sense, we may view knowledge as being in part a function of information and vice versa. Knowledge refers to a person's range of information and information to items of knowledge; knowledge carries the connotation of a higher degree of systematization (this is evident in the often used type of definition: "organized data is information, and organized information is knowledge." But then what is data?) However, it is also evident in another sense that information is a broader concept, involving in addition to knowledge, all kinds of signals and representations that effect our senses and biological processes. In

any case, the variety of viewpoints is a reflection of a variety in reality, thus substantiating the argument that in approaching information systems as utilities we have to consider that the very nature of different manifestations or aspects of information may be the prime factor affecting the degree to which an information system can become a utility.

6. Russell, B. Human Knowledge - Its Scope and Limits. N.Y., Simon and Schuster, 1948, 524p.

7. Shannon, C.E. and W. Weaver. Mathematical Theory of Communication. Urbana, University of Illinois Press, 1949, 125p.

8. Zipf, G. Human Behavior and the Principle of Least Effort. Cambridge, Addison-Wesley, 1949.

9. Tribus, M. and E.G. McIrvine. "Energy and Information", Scientific American, vol. 225, no. 9, Sept. 1971, pp. 178-188.

10. Harmon, E.G. Human Memory as a Factor in the Formation of Disciplinary Systems. Ph.D. Dissertation, Cleveland, School of Library Science, Case Western Reserve University, 1970, 132p.

11. Goffman, W. and T.G. Morris, Jr. "Quasi-Metric Spaces and Information Systems" Proceedings of the International Congress of General Systems and Cybernetics. (Oxford, England, 1972) London, Gordon and Breach. In press.

12. Pribram, K.H., ed. On the Biology of Learning. N.Y., Harcourt, 1969.

13. Brookes, B.C. "Numerical Methods of Bibliographic Analysis", Library Trends, vol. 22, no. 1, July 1973, pp. 18-43.

14. Goffman, W. and V. Newill. "Communication and Epidemic Processes," Proceedings of the Royal Society, A., vol. 298, issue 1454, May 1967, pp. 316-334.

15. Boguslaw, R. The New Utopians - A Study of System Design and Social Change. Prentice-Hall, Englewood Cliffs, N.J., 1965. 213p.