Title
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Publication Date
1977

Peer reviewed

THE SOCIAL DYNAMICS OF TECHNICAL INNOVATION IN THE COMPUTING WORLD

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TR #104

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November, 1977

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The Social Dynamics of Technical Innovation in the Computing World

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ABSTRACT

The "computing world," all those people and groups that collectively produce computers and computer-based services is an especially complex, dynamic and diffuse social world. Technical innovation is a dominant feature of the world. It is organized to provide a continuous flow of innovations from participants who specialize in innovation through many other participants to the final consumers of computer-based services. Technical innovations often flow across a large number of "markets" which are composed of only a few classes of participants such as "innovators" and "vendors" or of "users" and "consumers."

This paper identifies the major orientations taken on by participants in the computing world and examines some of the markets across which innovations are negotiated. The computing world is organized so that each market is biased in favor of innovations moving from suppliers to their customers. From this viewpoint, "innovation" is a dominant structural interest in computing around which participants organize their activities and to which they must continually adjust.

Acknowledgements:

This article is part of the URBIS Research Project: Evaluation of Information Technology in Local Government. This research is supported by a grant (APR 74-12158 AOI) from the Research Applied to National Needs Division of the National Science Foundation.

Howard Becker, Phillip Crabtree and Walter Scacchi provided helpful comments on this paper.

Introduction: Computing as a Social Phenomenon

The growth and diffusion of computer-based technologies is one of the most impressive social phenomena to emerge in this country since World War II. These technologies are associated with an enormous new industry [1], a host of new occupations, academic disciplines, and associations, new social and economic relationships [2], and the reorganization of many practical, theoretical and intellectual problems. In addition, computer-based technologies have begun to permeate the organizations which use them. In the last few years, computing has to appeared in our daily lives in the form of automated airline reservation systems, automated tellers, and point of sale terminals.

Consider all the people and organizations that help produce computer systems and computer-based services. We call these people and groups the "computing world" (Gerson and Kling, 1977) [3]. The computing world is a social world which is very diffuse, complex and dynamic. In a companion paper (Gerson and Kling, 1977), we have described the patterns of segmentation and intersection in this world. In particular, we stressed its high degree of differentiation and the way computing world participants appear in many work organizations which are not particularly oriented towards computing.

This paper, is concerned with technical innovation as a dominant feature of the computing world. In fact, we view the computing world as a production system for creating and disseminating technical innovations to a wide variety of users and consumers of computer-based services.

In particular, we focus on the implications of computing world structures for the frustrating and recurrent problems faced by people and organizations using computer-based technologies. Most people who use computing must encounter, not only the equipment (hardware and software), but also the organization of people who manage and operate the technology. Many problems faced by computer users occur in their dealings with the social organization of computer "service providers" as well as with the technology. Futhermore, both the social organization of service providers and the technologies provided are strongly influenced by the broader-scale social organization of the computing world. Many problems of computer use are a by-product of the relatively ambiguous social organization of the computing world which permeates many of the more localized, smaller scale social arrangemments which help shape it (Kling, Crabtree, and Scacchi, 1977). Thus, this study illustrates the way which selected small scale phenomena result from of larger scale social organization.

Computing world Participants and their Orientations

There are fourteen major orientations that people or groups may adopt within the computing world:

1. Technology Stimulators: people (or groups) who fund basic research and the development of new technologies. They include such groups as the Office of Computing Activities of the National Science Foundation or the Advanced Research Projects Agency of the U. S. Department of Defense.

2. Innovators: people (or groups) who create new computer technologies. They are usually situated in universities and research laboratories.

3. Diffusers: people (or groups) who adapt new technologies to a form that is tractable for other participants in the computing world.

4. Vendors: people (or groups) who produce and market computer products, particularly equipment or programs. Examples include such "mainframe" vendors as IBM and Burroughs.

5. Service providers: people (or groups) who provide computer processing. They may provide "raw computing," like computer-centers, or computer-massaged data as do firms that provide billing services.

6. Educators: people (or groups) who instruct others about the appropriate use of computer technologies.

7. Systems Architects: people (or groups) who design or fabricate hardware or very general purpose software which create "environments" in which more specialized programs are executed.

8. Applications Architects: people (or groups) who design or fabricate programs which can be applied to such special purposes as statistical analysis, accounting, or bibliographic search.

9. Users: people (or groups) who specify the way data should be manipulated so that it can be used in other work settings in which computer support is largely a means to some other ends. Since a computer system can be viewed as a hierarchy of data-manipulation schemes (Tanenbaum, 1976), we also add the condition that a "user" specifies his manipulations, in large part, using labels meaningful to other people who use that computer system purely as an instrument for other work.

10. Feeders: people (or groups) who prepare or enter data for computer input.

11. Tenders: people (or groups) who operate computer equipment fot use by others.

12. Sustainers: people (or groups) who maintain computer systems (hardware or software).

13. Hobbyists: people who use computing as a recreational device and receive no financial compensation for their activities.

14. Consumers: people (or groups) who utilize computer-based information but who do not manipulate the data they receive by using a digital computer. These include people who receive statistical analysis from a computer-based system but who do not use a computer to further manipulate the data they receive. It includes the readers of reports which include data massaged by computing. It also includes people who receive such computer-produced items as bills.

These fourteen orientations are ordered by their closeness to the "center" of the computing world. People or groups who adopt one of the first eight orientations tend to be very much "in" the computing world. People or groups who adopt the last six positions fall towards the periphery of the computing world. Some participants adopt one primary orientation, e.g., innovator or consumer, others some combination of orientations, e.g., an urban planner who writes his own programs ("application architect"), runs his own data ("user") and later uses those analyses for presentations to a city council ("consumer"). We distinguish between "users" and other parties (e.g. service providers) who may utilize computer-based equipment and services. In the common parlance of the computing world, a "user" denotes the client of some other participant. In that usage, a vendor salesman may speak of a computing center director ("service provider") as a "user." In the argot of the computing world, the participants we call users are "end users."

While many computing world members occasionally shift orientations, most participants develop careers around one or two primary orientations. Similarly, most organizations in the computing world develop specialized products that depend upon their assuming one or two related orientations. Note especially that innovators, vendors, service providers, users, and consumers are relatively distinct orientations that flourish in specialized settings. Thus, some organizations (e.g. research laboratories) produce new computer technologies. Their products are usually prototypes rather than cleanly engineered mass producible computer systems or services. Similarly, vendors retail computer products to customers who hope to receive cleanly engineered and reliable products [4].

Groups that innovate, diffuse, and sell technological innovations can keep those people who wish to use the technology for other work (e.g., billing) continually adapting to an ever changing technology which promises to solve new problems with each innovation. Many users of computer technologies are forced to adapt to innovations they do not seek, at the time they are provided. Adapting to technological change is a continual demand placed upon participants of the computing world.

Technical Change in the Computing world

The first modern digital computers were conceived little more than 30 years ago. Since then, the technology has moved from a situation in which such machines as the MARK IV or ENIAC were "one of a kind" creations to the current pattern in which a dozen major manufacturers in the United States market several relatively standard lines of machines. At present, there are well over 200,000 digital computers [5] in operation in this country (NBS, 1977). Over the same period, both hardware and software have become increasingly sophisticated and the speed for performing basic arithmetic computations has increased by several orders of magnitude. Thus, on the surface there are major components of change. The technology itself has undergone tremendous alteration, and the number of people and organizations using computers have increased dramatically [6].

The social dynamics of these two kinds of change are quite different. Particular organizations seem to adopt new uses of computing as the product of interest group activities (Laudon, 1974; Kling, 1976). Some parties promote particular uses of computing (e.g., statistical analyses or accounting) to an audience of potential users, service providers, and consumers [7]. Since computing is capital intensive (new applications often cost between $100,000 and $20,000,000) negotiations over computer applications often include resource controllers from computer using organizations. All these types participate in negotiations over computer use, and any of them may initiate requests for new or altered computer applications.

However, after a new computer application is installed and is operating, change doesn't stop. This observation differs from the common perception that the introduction of computing is especially disturbing for on-going social relationships, but that after some time (often several months), a new set of social relations is established as the organizational life returns to a state in which computing is no longer a disturbing influence. The next sections focus on the dynamics by which technical enhancements are diffused throughout the computing world.

The Social Dynamics of Technical Enhancement

Few organizations utilize computers that are twenty years old. For computing world participants, this is a mundane observation; in fact the opposite would be thought odd. After all, since the sophistication of computing machinery has increased so dramatically in the last two decades anyone would be thought odd, or at least obtuse, who wanted to compute with an "antique." To some users of computing, the desire to compute with an "antique" is less odd. One social scientist observed that the formulas for correlational analysis that he was using hadn't changed since the turn of the century; yet he had changed computer systems several times in the last five years. For him, a stable "correlation machine" would be an ideal device. While such devices are simple to produce, they are quite rare. Computer installations can stabilize their systems for five to ten years, although it is highly unusual for them to do so. The current arrangements for developing, producing, disseminating, and maintaining computer-based technologies seduce people into a world of continual change. Most serious computer users cannot protect themselves from frequently changing equipment or programs even when they would prefer not to [8,9].

Changes occur with different frequency and influence end users to different degrees. An operating system may change every two years (with altered versions twice a year) while the central processing unit is changed only once every four years. Some changes, such as replacing machines, may effect all users. On the other hand, changes of operating systems may influence only systems and applications programmers.

The frequent changing of machines and programs is in part a response of computer service providers to both specific and diffuse requests by their clients. For example, an engineer may wish a fancier version of FORTRAN than is currently provided at the facility he uses. A computing center may alter its operating system to help speed up "throughput" in response to a variety of requests to provide faster service. But many of the changes in machines and programs are made with little regard to user requests. For example, recently IBM announced that it was dropping support for a popular older operating system but would support its customers in "upgrading" to another class of operating systems. While this new class of systems (virtual memory) is in theory more flexible, it also consumes more computer resources than the systems it replaces. This is generally true: successive versions of operating systems usually consume more resources than their predecessors. Some computer specialists note that these additional resource demands are often unnecessary for the features provided (Moyle, 1977).

Given the pace of technical change in the computing world, one might expect that customers would frequently shift vendors. After all, at any given time, some particular vendor might offer a better array of services for a given price than his competitors. Is this the case with computing? According to a recent report (Business Week, 1977), about 25% of Honeywell's "growth business" comes from new customers. For IBM, new customers lead to 10% of its new sales. These figures indicate the extent to which service providers and other computer users tend to stay with particular mainframe vendors. We shall discuss three organizational features of the computing world that encourage this pattern: _technical coupling_, the use of _custom tailoring_, and the consequences of _specialist markets_.

Technical Coupling

Contemporary computer systems are composed of several dozen major hardware and software components. Some of these may be provided by the hardware vendor, some by outside software suppliers, and some developed within the computer-using organization. For a particular application to function properly, many of these components need to be _compatible_. Compatability means, in practice, that the conventions for formatting data and instructions used by two sub-systems must be identical wherever they interface. The requirements of compatability among components makes users dependent upon the technical coupling among components. A computer user encounters technical changes in three ways:

1. He sought it in order to improve the quality of his own computing applications;

2. He is sharing equipment and software with other users. The service provider alters the equipment or software to help meet demands for increased or improved service from <u>other</u> users.

3. The vendor initiates a software revision which is accepted by the service provider or other users.

The first situation places control in the hands of each independent user [10], the second with the service provider who is mediating the (possibly conflicting) technical, economic, and administrative demands of different users through a common shared facility. Each of these is a form of "market demand." The last situation, also quite common, is the focus in much of this paper.

Computer vendors continually "upgrade" or revise their software on a schedule driven by their own internal development schedules and the releases of their competitors. Each separate module in a computer system might be expected to have at least yearly minor revisions, "to help get the bugs out." In addition, vendors will not maintain software packages which are "several releases back." This pattern creates major incentives for a computer using organization to "keep current" with the stream of software modifications provided by the vendors [11]. These modifications, in turn, force additional changes in other software packages used within a particular installation.

The viewpoint of vendors was recently summed up by Norman Weizer, director of Univac's software strategic planning, at a conference of professional computer users:

> "If you remain current, you may have several minor conversion efforts which will be more of an annoyance than a problem. However, if you remain static for three or four years you may find that the conversion to the new generation (of software) will be very painful (Gardner, 1975)."

Users of computer systems could insulate themselves from these changes by maintaining their own systems software without relying upon vendors. Such a strategy is very costly, demanding special expertise to maintain the complex operating systems and language processors found on contemporary computing systems. Such a strategy may be possible in university centers where expertise is readily available or in very large computer installations, but it is less viable for small installations staffed by a few programmmers, each of moderate skill.

Custom Tailoring

As a second strategy for lessening the effects of technical changes, a service provider or user might select standard "packages" for every computer application. If there were a supply of standard packages, then a user might simply shift vendors if technical changes became too troublesome or costly. In practice, however, countervailing influences attract service providers and users to non-standard packages.

Vendors attract users by providing a marginally better product than their competitors. Service providers´ staff, both system architects and application architects, can have an easier job using computer products that provide more flexible and expanded features. Thus, each hardware vendor attempts to provide languages such as FORTRAN, BASIC or COBOL which are slightly different and incompatible with other providers´ versions. But those dialects which are most attractive to users because of their flexibility and programming ease are the most difficult to drop if switching vendors becomes an issue, since many programs have to be rewritten in the new vendor´s dialect.

Users and consumers of computer applications also have incentives to avoid standard packages. Most businesses and agencies have their own reporting conventions. Few groups are willing to alter their conventions to suit a particular format "demanded" by a computer system if they can alter it. In addition, managers and staff often seek unique reports and special analyses which require "minor" alterations of existing systems. In theory, such flexibiility is an attraction of computer use over manual record systems; data may be easily reorganized to serve multiple puposes. That lure leads computer users to alter their systems so that they cannot simply be dropped and replaced without large costs of data and program conversion. Again, the features that make technical variation attractive undermine easy transfer from one application package to an apparent replacement.

Markets for Computer Specialists

A third alternative open to service providers is to use equipment and systems supplied by less dynamic vendors. While there are many alternative suppliers for specific computing products, the decision to switch from one vendor to another is particularly costly. While a user may find several different vendors with "similar" products, the costs of converting software from the particular conventions of one system to those of another can be quite substantial [12].

This alternative also faces two problems. First, vendors are vying for business in a market in which more "bang for the buck" is a major attraction. Thus at the time a decision to contract with a particular vendor is made, he would have to provide relatively competitive system features in order to attract service providers. Since vendors are continually seeking new business, this places them under unending pressure to remain technically current.

Secondly, the architects hired by service providers in a highly dynamic job market in which technical obsolescence is a common threat. "Generations" of equipment last for five or six years and employers seem to seek staff who have particular experience with the specific machines, languages, and configurations they are using [13]. Thus, architects have a strong incentive to work with state of the art systems. For example, the Department of Data Processing in the City of New Orleans "upgraded" its operating system twice in two years. According to the Director of Finance who supervises the computing operation:

> We can't pay our staff salaries that are competitive with local businesses. We had to provide a challenging technical environment to keep them interested.

Both the competition between vendors for business and the competition amongst computer specialists for jobs create pressures supporting a steady stream of technical enhancements.

Negotiation of Structural Interests in the Computing world

Negotiation consists of interaction among sets of parties which allocates resources. Strauss further specifies features which define a negotiating context (Maines, 1977). In his parlance, the negotiations over technical change in the computing world are usually explicit, constrained, involve many participants in overlapping settings, are repetitive and interrelated. The negotiating contexts of special intertest to us contrast with other negotiating contexts which, for example, may usually be implicit, unconstrained, involve few participants acting alone, are single events, and sequential. A central issue is the nature of the constraints that appear in these settings, the strategies used to maintain them, and their consequences.

Sociologists have studied several common strategies parties may use to constrain [14] the negotiating contexts they share with others. These include administrative rules (Friedson, 1975;Strauss, 1971), laws (Becker, 1963; Alford, 1975), legal contracts, and pricing policies (Farberman, 1975). We have already shown how participants in the computing world use another device, "technical variation", to constrain negotiations over technical change.

One important property of the constraints that define a negotiating context is the extent to which they preserve parity. Constraints preserve parity if they enable each party to have a good chance of satisfying his goals in the setting without necessarily using disproportionate resources relative to other participants. Parity-preserving constraints may limit the courses of action the participants are most likely to take, but they do not bias the outcomes. A common example of parity-preserving constraints are game or handicap rules. Formalized games and contests provide examples in which the bias or parity-preserving properties of constraints can be relatively negligible. For example, handicap rules are designed to give players with equal skill, but with other resources unequal, an equal chance of winning a given contest. When the participants take on distinctive roles, parity-preserving rules should afford parties in different roles an equal chance to attain their goals. Of course, in each actual negotiation, many different aspects of the situation, and players skills in exploiting or coping with them, may give some participants a better outcome than others.

Constrained negotiating contexts may include many partipants drawn from overlapping settings. In such situations, constraints in one setting can severely constrain related negotiations taking place in another setting (Gerson, 1976). If Y contracts with X to purchase exclusive rights to a novel, that limits X's ability to sell movie rights to the novel to Z. Y and Z need have no awareness of each other in order to be bound by a system of constraints via common contracts with X.

Following Long(1958), we consider a community to be a collection of people (and groups) who participate in overlapping negotiation contexts. Participants in related negotiations need not be aware of each other, let alone act in concert. Interest groups partition a community into groups that share common goals in related and specific negotiating contexts. Such a definition leaves open the question of whether people labelled with a common interest are aware of each other or engage in any joint activities.

Alford's (1975) analysis of the New York City health care system suggested yet a different way to partition a community into groups e.g., those that are differentially advantaged by commonly accepted constraints form a structural interest. He distinguishes interest groups and structural interests:

> The distinction must be made between the organized action of a group to represent its interests (an 'interest group') and those interests served or not served by the way they 'fit' into the basic logic and principles by which the institutions of a society operate. For want of a better or more conventional term, I shall call the latter structural interests. These are interests which are more than potential interest groups...which are merely waiting for the opportunity or the necessity of organizing to present demands or grievances to the appropriate authorities. Rather, structural interests do not have to be organized in order to have their interests served or cannot be organized without great difficulty (Alford, 1975).

Alford's analysis focuses upon a special case in which a community is partitioned into three structural interests:

- <u>dominant interests</u>--those parties who are best served by a particular set of constraining devices;
- <u>challenging interests</u>--those parties who receive some benefits from a particular set of constraining devices. These same parties are <u>also</u> acting as interest groups to alter the constraining devices to serve them better;
- <u>repressed interests</u>--those parties who are severely handicapped by a set of constraining devices.

The computing world contains three major structural interests: "technological innovation", "user orientation", and consumer/citizen interests. The first is dominant. That is, the computing world is structured so that innovative technologies continually emerge and are disseminated on a large scale soon after they become economically feasible. In contrast, user orientation is a "challenging interest." Lastly, consumer/citizen concerns represent a "repressed interest". "The nature of institutions guarantees that they (i.e. repressed interests) will <u>not</u> be served unless extraordinary political energies are mobilized" (Alford, 1975).

Negotiating Contexts in the Computing world

The preceding account indicates that negotiation over technical change takes place in overlapping settings. This section explicates these negotiation contexts more carefully by focusing on those that include participants with selected orientations. Innovations in the computing world flow through an ordered array of markets. Each market is a collection of negotiating contexts in which participants from different subworlds bargain and exchange resources. In addition, markets are characterized by the competition of participants for (scarce) resources. In this section we focus upon those markets defined by the joint participation of innovators, vendors, service providers/architects, and consumers. These markets are particularly interesting because technical innovations flow through them from inventors to ultimate consumers.

Innovators

Major technical innovations in the computing world (high-level programming languages, timesharing, multiprogramming, virtual memory, data base management, networking, electronic mail and text processing) have evolved from the laboratories of specialized innovators. Most innovators produce concepts or prototype artifacts that illustrate a technical concept. Over several years, innovators tend to shift from concept to concept rather than sticking with one idea and developing a stream of fine enhancements. In the different specialty areas of computer science, concepts become dated rather rapidly, in years rather than decades.

Innovators generally deal with each other, with technology stimulators from who they seek funding, and occasionally with vendors who they hope will market and diffuse their developments. New approaches may be publicized in technical journals and conferences or through internal memos and meetings inside vendor firms. But innovators receive few advance commitments from vendors that their products will be developed and marketed to service providers.

Vendors

In contrast to innovators' focus upon developing new concepts, vendors sell products that are broadly marketable to service providers and computer users. Vendors include both such corporate giants as IBM and small firms that market a special peripheral device or software package. In principle, vendors turn to service providers as their clients, altnough some vendors turn to users and consumers as well to help gain commitment for expensive equipment purchases (Kling, 1975).

Vendors turn to innovators both to find ways to improve their products relative to their competitors, and to insure that they won't be caught short by more innovative competitors. But the major problem for vendors is maintaining a flow of profits that can support their enterprise. New sales may come from new customers, if the market isn't saturated. Expanding markets usually attract highly competitive entrepeneurs. Such competition creates pressures to either cut costs or to provide a technically enhanced product.

But for many computer products the number of potential customers is relatively limited, at least in the short run. For example, there is a limited market for very large scientific computers. Nevertheless, it takes considerable capital and organized talent to build such machines. Thus, a major issue for mainframe vendors is to find ways to sell new products or enhancements to existing customers. Improving the price/performance ratio or enhancing the overall capabilities of existing equipment lines are such devices. Forcing obsolescence of existing equipment is another.

In an earlier section, we illustrated the way computer vendors can exploit technical variation as a device to attract service providers and users to their equipment , and then lock them into a continual flow of alterations. Here we wish to note that technical variation is not a parity preserving constraint. It helps vendors maintain their current customer base by making the decision to shift vendors very costly for a service provider (Upton, 1977).

Service Providers/Architects

Service providers have to maintain smooth computer operations for a variety of users. These operations depend upon their ability to develop and maintain computer systems at relatively low cost and maintain a skilled staff of architects. In addition, they depend upon being able to attract and keep a variety of users as customers. They also depend upon vendors to supply and maintain equipment. Each participant that service providers deal with yields to different strategies.

The constraining devices open to service providers vary, depending upon their organizational setting. A few service providers, such as service bureaus, operate in the open market and attempt to attract users traditionally, by offering services at lower cost than their competitors. However, most service providers are situated within the organziation for which they provide computing. In some cases they can create administratively mandated monopolies, for example, by engineering guidelines which make it difficult for potential users to seek services "outside" or fighting off attempts by user coalitions to develop their own competitive computer centers. In addition, custom tailoring software helps keep users committed to the same facility.

Exchanges between service providers and vendors are much more subtle. Vendors provide new technologies and skills in using them which provide career attractions to service providers and their staffs. But, vendors also occasionally push products a particular facility may not need or cannot justify to its users. However, when technical innovations are adopted by service providers, they are necessarily passed on to the users and consumers of their computing systems, whether or not they sought them. Because computing facilities are typically shared rather than individually consumed like cars and cameras, changes in the facility affect many users and consumers simultaneously.

Users

Users often consume the information they produce. However, there are many more consumers than users. Nevertheless, users often serve as surrogates for consumers "downstream." However, there are important situations in which this is decidedly not the case. In scientific settings, users traditionally remained close to the development of their own computer applications; in business and public agencies, they often turn to applications architects help in formulating their problems for computer-aided solutions.

In dealing with computer innovations, users of computer-based information systems are in a difficult situation. They are often unaware of current technology and its capabilities. In addition, automated information systems are a shared organizational resource rather than a private good (Kling, 1974) because of the dependence of large organizational operations upon routinized flows of information and because of the costs of altering those flows. Thus, "the user" of an information system often refers to a wide variety of organizational members with different desires and interests in the kinds of information they may recieve (Kling, 1975).

Users of computing benefit from two classes of innovations: their applications may change and the core technology which "supports" their applications may change. Both these alterations are subject to the same dynamics of technical change described earlier. In theory, users are the primary market and beneficiaries of computer innovations. In practice, they are often constrained by the local monopoly of computing in their organizations as well by the constraints placed upon their local center by the vendors.

Nevertheless, we would expect relatively frequent negotiations between service providers and users. Table 1 indicates the extent to which users of computing in American local governments participate in certain selected activities according to respondents in their computing facilities.

Insert Table 1 about here.

It is striking that, according to the reports of service providers, in 25% of cities and counties users never or seldom review designs for computer applications. Based on field studies in two dozen American local governments carried out over the last three years, we find that users are often in weak positions when negotiating with service providers (URBIS Group, forthcoming). If there is bias in these reports, it is because service providers usually overreport the level of involvement of users in decisions about computer use.

Consumers

For analytical purposes, we distinguish between three kinds of consumers: people who hold positions in an organizational hierarchy "above" a computer user, members of a common organization with a computer user, and clients of an organization which uses computing.

The first two classes of consumers may be able to negotiate with users to alter computer-based reports to serve their needs, but the clients of an organization are often in a different negotiating context entirely, since they usually have no authority to negotiate with service providers or users.

Our data on user participation in negotiations suggests that even the first two classes of consumers may be in weak positions relative to service providers. Negotiations between the clients of computer-using organizations and service providers or users regarding computer-based records should probably be even less common and more constrained.

Public controversy over computer-based systems such as the National Data Center represent, in part, a rare mobilization of citizen concern about a particular computer technology. More commonly, new technologies, such as electronic funds transfer systems, are negotiated between technology innovators and such large institutional users as commercial banks. In such a development, consumer interests are generally neglected by vendors, service providers, and users (Kling, 1975).

The Balancing of Interests

Our account of the computing world indicates that it is not organized simply to "provide computer services" to a large group of consumers, but that it is also organized to "sell" a wide variety of innovations and technical enhancememnts to computer users. While many of these innovations may be improvements, many are sought by neither consumers or users at the time they are introduced. Some innovations are "forced" upon service providers by vendors as part of a larger marketing strategy. Other innovations are sought by service providers and passed onto to users and consumers, and many more innovations are selected by users [15] and passed onto consumers [16].

Given these conditions, "innovation" becomes a dominant interest. A participant in the computing world may have to use an innovation that he did not seek and that does not serve him, but over which he has little control, in many ways. During the last decade, "user involvement" has become a challenging interest. However, consumer interests are difficult to mobilize or bring into negotiating contexts with users, service providers, or vendors. They are "repressed interests."

Why is tnere no consumer or user revolt? The way computer innovations are diffused across a wide variety of local markets means that (dissatisfied) participants may be able to negotiate "adequate" arrangements that improve their own positions without altering the larger structure of negotiating contexts in the computing world, and since each participant faces a long chain of increasingly remote suppliers, few participants can mobilize resources to negotiate wide ranging contracts "several markets away."

In each market, many participants may be well satisfied by what they get for the resources they invest. Even those participants who make out "least well," users and consumers, on the whole receive some benefits from computing (Laudon, 1974; Greenberger, et. al. 1976; Kling 1975, 1976). In addition, over time, computing and the services it supports become faster, cheaper, and more computationally powerful [17]. Thus small negotiated adjustments and the hope of improving technology worked out in small settings provides some stability to the larger computing world and its market organization.

Conclusions

The computing world is composed of a diverse participants who can take on at least 14 distinct orientations. Technical innovations, a major concern of the computing world, are developed by specialists ("innovators") and slowly move to consumers across several markets. As innovations move through the computing world, they become subject to an increasing number of constraints that are negotiated through the sequence of markets indicated in this paper. Thus, technologies which appear quite plastic to their developers may turn out to be relatively constrained when they reach the public.

The computing world is organized so that each market is biased in favor of innovations moving from suppliers to their customers. From this viewpoint, "innovation" is a dominant structural interest in computing around which participants organize their activities and to which they must continually adjust.

NOTES

1. In 1976, the six largest American computer manufacturers reported sales of $23.8 billion, assets of $26.1 billion, and employed 590,000 people (Fortune, 1976).

2. In 1975, American and city and county governments reported direct expenditures of over $400 million for computer services. While these expenditures average about 1% of municipal budgets and 1.3% of county operating budgets, they lead local agencies into complex contracts (Kraemer, Danziger, and King, 1976).

3. We follow Becker(1976) in basing our definition of a social world on the joint production of specific actions and services rather than on the networks of communication suggested by Shibutani (1955).

4. Vendors may sell one-of-a-kind systems as well as mass produced systems.

5. We refer exclusively to stored program machines with some kind of secondary storage (tape or disc) and do not include the increasingly sophisticated pocket calculators that have become popular in the last few years. The rapid proliferation of microprocessors as components of other devices, e.g., word processing equipment, is blurring the distinction between what is and what is not a computer.

6. By 1965, 48% of American counties and 53% of American cities with populations over 100,000 had adopted some computer applications. By 1975, 98% of those counties and 97% of those cities had adopted some computer application. Of the cities with populations between 50,000 and 100,000, 25% had adopted computing by 1965 and 92% had adopted computing by 1975 (Kraemer, Danziger, and King, 1976).

7. As we shall see, consumers of computer services are often locked-out of the actual negotiations over the adoption and design of computer applications and the technologies to support them.

8. Under special circumstances, service providers have been known to "move back" from a late model machine to a larger version of an older machine series which sells at lower cost on the used equipment market. Such moves are rare however.

9. For example, in 1976, the U.C. Irvine campus computing facility initiated 107 substantial alterations to the software packages in use on one of its major machines. These do not include alterations initiated independently by users of the facility on their own applications. More broadly, 40% of the computer installations in American city and county governments indicated they had changed generation of their machine between 1973 and 1975. An additional 38% indicated they were expecting such a change between 1975 and 1977 (Kraemer, Danziger, and King, 1976).

10. However, "user" may refer to a rather complex array of people and groups who share a common computer application. See for example, Laudon (1974) and Kling (1976a).

11. Generally, vendor staffs are advocates of systems changes (Crabtree and Kling, 1977). A previous director of education at IBM recently noted that IBM's style of rotating and educating it employees has generally influenced the attitudes of its staff towards change. He noted:

> "As a side benefit (of its educational policies), IBM has ended up with a work force that believes in change (Business Week, 1975)."

12. It is hard, in general, to cite figures for conversion costs independent of a specifiic situation much in the way it is hard to cite the costs for "renovating a building" without knowing its architecture and the transformation desired.

13. This point can be easily supported by studying the advertisments for programming jobs in daily newspapers and trade jouurnals. The requirements are usually listed in terms of experience with quite specific machine configurations. They are equivalent to ads for chauffeurs that would read: "Wanted, person who has two years of experience driving a Blue, Mercedes 300D with radial tires, a 16.5 gallon gas tank, and a Blaupunkt Model 2705A AM/FM/Cassette unit."

14. As some studies have shown, constraining devices themselves may become topics of negotiation. See especially Strauss (1971) and Friedson (1975).

15. However, it is not true that computer users can receive many alterations in systems that they seek. Many service providers are overloaded with requests by users for altering existing programs and developing new ones. They choose which innovations to advance based upon a delicate political balance between the cross pressures of the vendors, staff career interests, and the departmental politics of the computer-using organization.

16. Not all innovations are automatically flushed through the markets from innovators to consumers. An important example is programming languages. While over one hundred different languages have been developed in the last two decades, half a dozen languages dominate the computerworld.

17. Concerns over reliable and easily maintainable software were first articulated by various users and service providers. However, these concerns were translated into new technical problems for an emerging subspecialty, software engineering, and have been tackled by technology innovators.

Table 1

Participation of User Department in Data Processing Activities*

Activities	Never	Seldom	Often	Always
	Percentage of installations Indicating that users participate			
A. Perform systematic analysis of benefits and costs anticipated from a proposed computer application.	23	48	21	8
B. Review designs for a new application	6	19	36	38
C. Provide test data for an application	19	35	31	15
D. Sign off, accepting an application.	26	27	24	23
E. Provide informal feedback on problems with the data processing unit.	Ø5	15	49	31

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* Based on a sample on 473 cities and counties from a survey administered in 1975.

Question: "What is the frequency with which users of your data processing unit do each of the following?"

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