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ABSTRACT

One abstract and sixteen articles on computer networks and information systems guidance programs presented at the Association for Educational Data Systems 1976 convention are included in this document. Computer networks and information systems are discussed in eight articles: four articles describe regional educational information systems, three describe planning of interactive networks, and one paper describes multiplexing designs for use among university information networks. Six articles on computerized guidance and career planning information systems are included. In addition, there is a paper on computer analysis of survey questionnaires, and a paper describing the impact of the computer revolution. The last paper addresses the problems of teaching computing concepts to educators. (CH)

NETWORKS; COMPUTER NETWORKS WORKSHOP and GUIDANCE. Papers presented at the Association for Educational Data Systems Annual Convention.

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The 1976 AEDS International Convention

Proceedings

TODAY'S REVOLUTION:
COMPUTERS IN EDUCATION

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EFFECTIVE USE OF THE COMMON CARRIER IN A UNIVERSITY COMPUTER NETWORK

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ABSTRACT. The advances in the data communication technology have provided many new techniques to a university or a region computer center to serve their remote stations and terminals more effectively. By using the multiplexing techniques on the communication link, it can provide many advantages, such as flexibility, easily maintained, and economical. Several designs of multiplexing will be discussed - the use of the common carrier among the several university networks. The voice band will be used as an example to show the effective use of the common carrier.

Commercial Common Carrier

Over the years, the common carrier has been the principle service for data communication. Although, there are thousands of companies that provide the common carrier in the country, the highlight of the common carrier can be summarized as follows:

A. Narrow Band
- for the transmission up to 300 bps
- driven by the common carrier through multiplexing a voice band, sometimes referred to as "sub-voice"
- filed in FCC tariff 260 as series 1000

B. Voice Band
- data transmission rate is about 300 bps to 10,800 bps
- capable of transmitting voice or data information
- filed in FCC tariff 260 as 2000, 3000, 4000, and some 5000 series offering

C. Wide Band
- obtained by combining some number of voice band equivalences
- common speeds and voice equivalence
  - 19.2 K bps : 6 voice link
  - 50 K bps : 12 voice link
  - 230.4 K bps : 60 voice link
- filed in FCC tariff 260 as series 5000 and 8000

D. DDS*
- T1 carrier multiplexing 24 speech signal digitized, output of T1 is 1.544 M bps
- for data and point-to-point only, sub-channel 2.4, 4.8, 9.6 K bps available
- higher error free rate 99.5% and up
- line speed equivalences
  - T2 output 6.3 M bps : 4 T-1 carrier
  - T3 output 46.3 M bps : 7 T-2 carrier
  - M34 output 281 M bps : 6 T-3 carrier
  - T4 output 564 M bps : 2 M34

In selecting a communication line, there are three (3) major considerations: 1.) Information load and rate for transmission; 2.) Communication line quality; 3.) Cost factor.

Because the voice grade (series 3000) is still most commonly used in computer data communication, it will be selected as an example to discuss its facilities with regard to the above parameters.

Generally, there are four (4) basic rate structures of the communication services:

1. wide area telecommunication service (WATS)
2. direct distance dialing (DDD)
3. foreign exchange
4. private or leased line

The first three (3) catagories are normally defined as switched facilities i.e., it is connected on a demand basis. As far as the line quality is concerned, the leased line has proven to be up to the maximum transmission rate of the voice band line because there are various circuit conditions offered to eliminate the impairment of the communication line, such as C-conditioning and D-conditioning. For the switch network, it may go through vast numbers of routing combinations as possible on the telephone network, thus the line quality is more limited than the leased line. Consequently, the cost factor of the basic communication line is affected by both the rate structure and the quality of the line.

Let's assume now that a communication line is selected to use for a group of terminals. One simple question will certainly be asked, "How many terminals can be run on the line, at what speed?". This has always been one of the

*AT&T recently filed rates and regulations for DDS, a private line interstate offering for data communications, which would be provided over a digital network for 96 cities in 1976.

characteristics of the communication: once the communication is established, there will be immediate need to expand its capacity.

With the advance of technology, the techniques of multiplexing seem to be a solution to solve the problem. It can effectively use a common carrier to its maximum rate structure and line quality. At the same time, it may reduce the cost, and provide other advantages to the network.

Multiplexing Technique

Multiplexing is a technique of simultaneous transmission of more than one transmission over the same communication line. It has been used by common carriers for many years, for example DDS uses extensively multiplexing.

Principally, there are two (2) types of equipment built for multiplexing: multiplexer and concentrator. They share the basic concept of multiplexing, which is to use one high speed communication line and subdivide it to provide a variety combination of terminal and speed.

However, there are two (2) basic differences among these two (2) devices: 1.) A multiplexer uses the method that the sum of band-width for the terminal is approximately equal to the total band-width of the communication line; while the concentrator may serve more terminals even if the sum of the band width of terminals is bigger than the actual available track. The concentrator provides more dynamic allocation of band-width; it can be viewed in the same concept of virtual memory system. 2.) Concentrators have added more ability to perform the error correction than the multiplexer.

A basic selection rule of multiplexing equipment will mainly depend on two (2) factors: 1.) the method of error correction and 2.) cost difference! The concentrator, also referred to as an intergrated front end, is usually more expensive. Hence, it is mostly used with specific interests in mind. The multiplexer is capable of performing network diagnostics (not error correction), and it is usually less expensive. Therefore, it is more popular.

Two (2) different types of multiplexers are most commonly used: 1.) Frequency Division Multiplexing (FDM) and 2.) Time Division Multiplexing (TDM). The TDM can handle more terminals because it uses the time division concept rather than the share of frequency band-width used in FDM. So it is the most commonly used.

The effective use of the common carrier by means of multiplexing has the following advantages:

1. It maximizes the utilization of the line, i.e., it will allow as many synchronous and asynchronous terminals to be both implemented as long as the same band-width of the terminals does not exceed the total available band-width.
2. It is reliable, i.e., it maintains high degrees of performance as compared to other methods of telecommunication, such as point-to-point.
3. It is easy to maintain, i.e., it will eliminate the number of phone lines, at the same time, it provides a certain method of network diagnostics.
4. It allows for future expansion, i.e., more terminals can be implemented until it reaches the line capacity.
5. It is economical, i.e., the cost per terminal will eventually go down as more terminals are implemented on the same communication line.

Obviously, in designing the multiplexing telecommunication, there is one disadvantage,

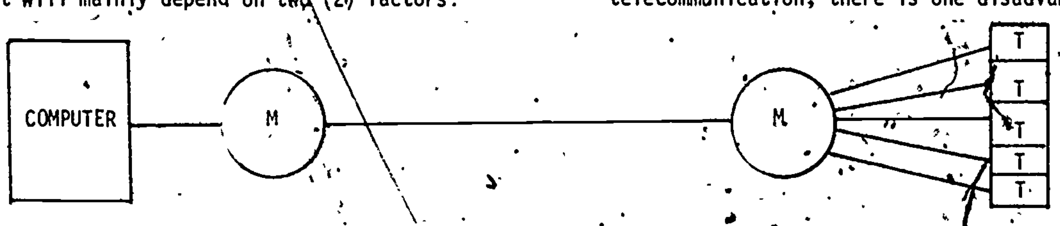

Figure I. Simple Multiplexing Network

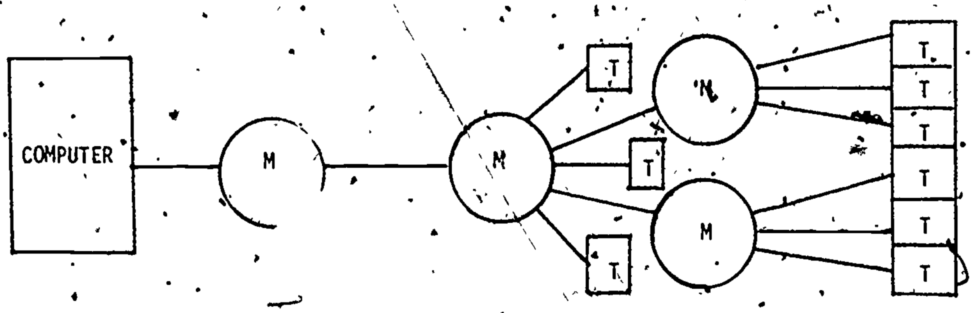

Figure II. Tree Structure Multiplexing Network

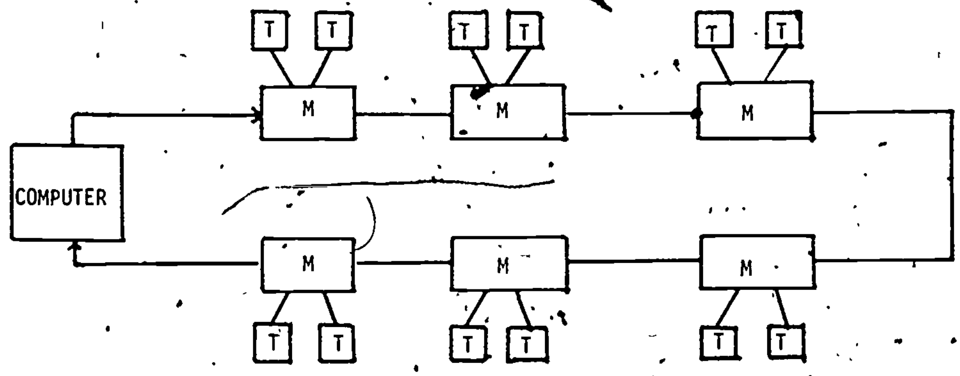

FIGURE III

LOOP STRUCTURE MULTIPLEXING NETWORK

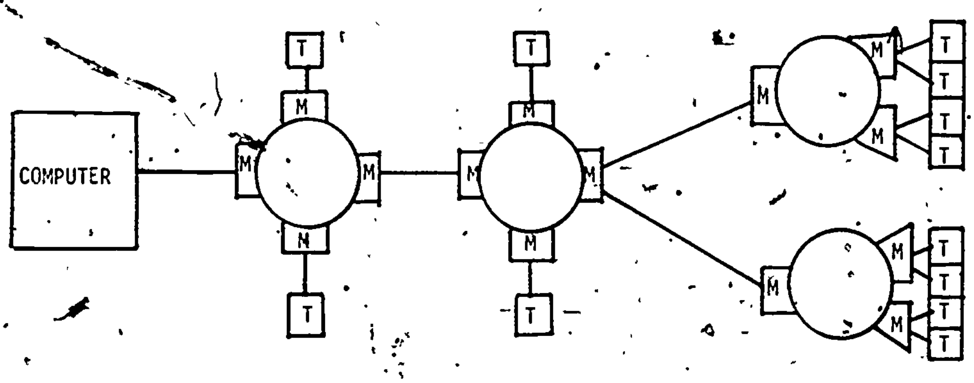

FIGURE IV

LOOP-TREE STRUCTURE MULTIPLEXING NETWORK

i.e., if the communication line is malfunctioning, it will cause more terminals to become inactive. Hence, line redundancy is usually required.

Generally, there are four (4) methods of multiplexing that can be classified:

1. Simple multiplexing network - a network to support a group of terminals with a multiplexing device and trunk line as shown in Figure I.
2. Tree structure multiplexing network - a network is divided into subnetworks and connected together with tree structure as shown in Figure II.
3. Loop struture network - a network of the multiplexing devices and connected through a loop structure as shown in Figure III.
4. Loop-tree structure network - a network is constructed with the combination of tree and loop structures as shown in Figure IV.

The second and third catagories may be used among nationwide networks, such as TYMNET, and the third and fourth catagories may be used to apply to more complex networks, such as ring computer network.

In a small to medimum scale of the communication network, the first or second catagories have been widely used, such as in the university network, the Iowa regional computer center network, Datacom network of the University of Indiana.

A Case Study of Multiplexing Network

Traditionally, the network design in a regional computer center with a lot of smaller computers or remote job entry stations and time sharing terminals to serve, tends to separate the use of common carrier by distinguishing the synchronous and asynchronous devices. By taking advantage of multiplexing, a common carrier can be used for both synchronous and asynchronous transmission at the same time.

Let's suppose that a regional computer center intends to design a network to serve a 4800 bps synchronous RJE station (or to connect to another computer) and 15 - 110 bps asynchronous terminals.

Obviously, there are several ways to design the network. Let's examine the pros and cons of some of the designs typically used.

First of all, when a point-to-point connection is used, it will require a total of 16 phone lines, i.e., one voice grade line for high speed and 15 subvoice lines for low speed. The advantage is the simple designing. The disadvantage is the cost is high.

Secondly, a point-to-point is used for high speed terminals; multipoint with FDM is used for low speed terminals. There are 12 subvoice lines that can be eliminated. Consequently, it will be less expensive than the first method, but it does not allow for future expansion.

Thirdly, a point-to-point is used for RJE terminals, while a TDM multiplexer is used for low speed terminal connection as shown in Figure V (this method is used at Iowa regional computer network). In this case, only two (2) unconditioned voice grade lines are used. The total band-width of 15 terminals is 1650 bps. This means the remainder of 2150 bps (4800 - 1650; assuming un-

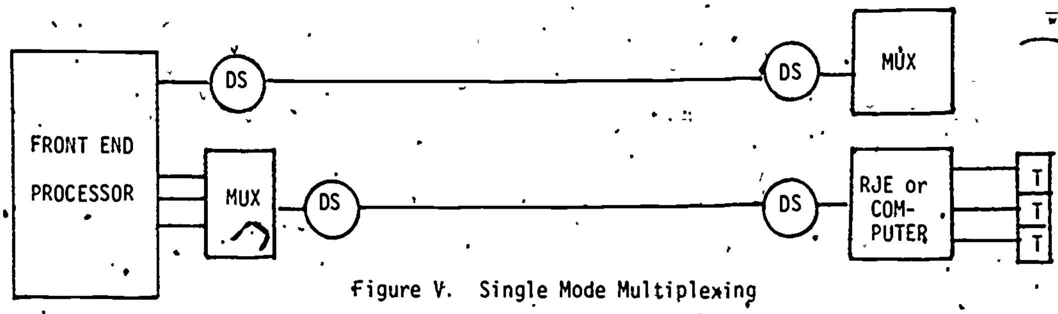

Figure V. Single Mode Multiplexing

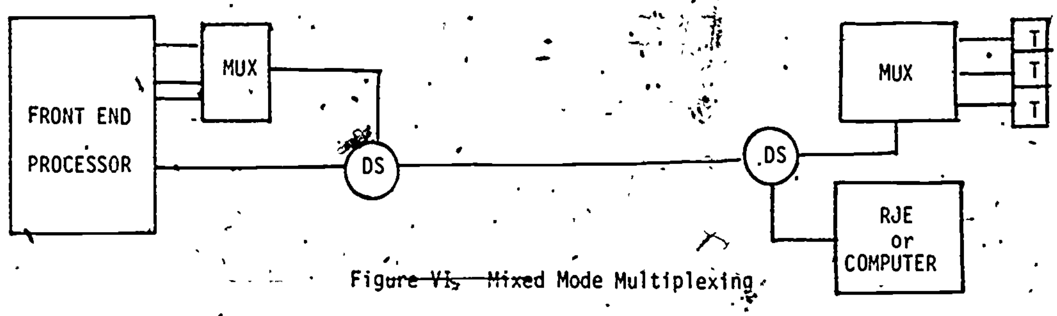

Figure VI. Mixed Mode Multiplexing

conditioned lines will use up to 4800 bps) can be used for future expansion. The network is easy to maintain because the feature is provided by the multiplexer.

Fourthly, a conditioned line (up to 9600 bps) is used for both high and low speed terminals as shown in Figure VI. (It is used at California State Universities and Colleges networks.) Thus, the need of the common carrier is reduced to only one. The network is easy to maintain and allows for future expansion. Another advantage of the fourth method over the third method is to utilize the communication line at its maximum rate. The multiplexing can be split into a 7200-2400 bps combination for synchronous and asynchronous communication. In this case, the increase of available widths for synchronous transmission will certainly increase the line throughput.

It is certain that the requirement of the line redundancy is propositional to a number of communication lines used in the network. The cost analysis of the above four (4) methods can be tabulated as shown on Table I.

From the table, the second method seems to cost less than the others simply because it requires only 3 voice grade lines for the asynchronous terminal. However, it is not generally used because of two (2) reasons: 1.) it does not allow for future expansion, and 2.) it does not offer network diagnostics which is usually provided by the multiplexer.

This case study is essentially a case in a simple multiplexing analysis on a voice grade line. When a requirement of communication

Table I: Cost Analysis of Case Study

Method	Phone Line #	Phone Line Cost	Cost Extended (Estimated)	Total Cost
1	16	$900	0	$900
2	4	$530	0	$530
3	2	$260	$600	$860
4	1	$160	$600	$820

NOTE: 1. Distance is assumed 20 miles.
2. Cost extended to include only the cost required to change from methods 1 and 2.

network is increase the same concept can be extended to apply the high rate of the common carrier to more complicated tree or loop structures.

Summary

The effective use of the common carrier will rely on the use of multiplexing because of the following attractions: 1.) it is economical, 2.) it is flexible, 3.) it is reliable, and 4.) it is easy to maintain. Thus, the method of multiplexing has become more popular to use. It is clear that its demand will be greatly increased in the near future.

It is recommended that the network system design and management shall be based on the above attractions to evaluate the cost versus reliability and performance analysis. Undoubtedly, a simulation model can be developed to provide the detail of analysis.

The dilemma of using the common carrier in leased or switched networks will essentially depend on the improvement of communication technology. In the ARPA network, it has shown a high degree of success to use the minicomputer as a concentrator to permit a number of users to share the same communication network. Other features, such as packet switching, error detection and correction, and a standard network protocal to permit a terminal to communicate with various computers, has also proved to be very valuable.

When this concept is applied to regular telephone switching systems, such as FCC has recently granted a new class of carrier called Value Added Network (VAN), the cost of data transmission will be calculated based on the amount of data transmission regardless of distance.

There are two (2) significant improvements that will be provided when this service is available: 1.) it will be more cost justified as compared to existing phone networks, and 2.) it will provide more reliable service because there is more error correction provided.

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RESEARCH ON NETWORK ENVIRONMENTS FOR EDUCATIONAL DATA SYSTEMS

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ABSTRACT: The 'full system' concept as to networked computers is developed--as also the concept of 'scientist-primacy' or 'educator primacy' networking. Properties of a virtual network as it could be used by computer science teachers are instantially elaborated. Having considered research on networks in the perspective of differentiated types of computing (as, for example, that required by computer science itself as an academic discipline), a contrastive, even orthogonal, viewpoint is taken: i.e., research on certain properties all such systems will require.

In the long perspective of human history we observe that as to the quality of life, the availability of information--and, of course, the uses to which available information can then be put--is, without caveat or quibble, the single most crucial determinative variable.

If we assume for at least all but the more recent historic past a rough constancy in environmental dynamism (e.g., ecological conditions not variable enough seriously to stress the species) and also assume a rough constancy in genetically determined components of central nervous systems' information processing capabilities, the differences in social life from time to time and place to place may be treated as more critically a matter of informational variability than of any other variable set.

The underlying condition of poverty--in materialities as well as in mind (e.g., stimulus deprivation, intellectual barrenness, etc.)--in our own day and throughout history is informational deficit. Man not having changed crucially and (at least until recently) environment not having changed crucially, what makes any of us different from people in other historical times, places, and cultures is, primarily, what at any given time and place we know. That most elemental difference, the difference between repetitious behavior and creativity, is also a matter of knowledge.

In such a broad, humane context we may see much more sharply the salience of the issues tied to the development and wide utilization of the information productive, disseminative, and coordinative roles of computer to computer communication networks. And it is primarily in educational institutions that we expose people formally to organized information--and where, also, we provide some of our most powerful role models for information use in later life.

If there is one star to steer by as to network research, that would be the need for a systems approach. An examination of the current research literature bearing on networks makes it evident that there is a good deal of activity on many fronts--including studies of hardware, communication, software, management and organization, human factors at the system interface, and others. We need to continue efforts on each of these fronts, and it may be urged that we also need to give special attention to <u>integrating</u> these types of efforts--as also to the enculturative role of educational institutions' network arrangements, inasmuch as their character will profoundly affect how today's students will make use of information networks as tomorrow's adults.

We need a science of network systems as such, where a network system is defined to be inclusive of all facets of its structure and functioning--the various human facets, hardware facets, communication facets, software facets. And note well that the human facets must include the learning history as to networks to which students are exposed in educational institutions. It is clear to everyone that while there is a lot of art that goes into, say, computer system hardware architecture or into programming, the <u>results</u> of that art--as also with the generation of scientific theory, be it said--have to meet increasingly demanding criteria of scientific rigor, such as, for example, expectations as to the quality of the applications software. Apparently it is not quite so evident to date to the practitioner community that we need comparable expectations as to scientific quality for our understanding of human participation in such systems (including just how they are experienced--learned about--in schools), and, notably, for our understanding of the total system of men and machines and programs in coherent interaction.

The problems in achieving a genuine science of man-machine behavior in its full complexity constitute a decidedly non-trivial research frontier. Despite our heavy reliance on science and technology, as a civilization we have given comparatively little attention to understanding in any strict scientific sense the interplay between people and, on the other side, the dynamic structures of technology and science. There is a research frontier worthy of our best attention and support, both in respect of its social importance and its intellectual challenge.

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Thought of abstractly, he uses to which computer scientists as teachers could put a network capability dedicated to their service would be very much what people in other disciplines would use a network for. That is to say, the network would be important for access to data, to analytical programs, to special purpose equipment, and it would facilitate communication among members of a research and teaching community. There are also expectations of economies of scale and specialization. Beyond those strong reasons for a computer network for computer science, there is, further, the advantage to be gained by enabling computer scientists to have the experience with networks which they could then generalize and convert into useful vicarious exprience appropriate to other disciplines and teaching specialties. That experience could include the development of prototypes in hardware and software and organization. There is a special additional advantage to the educational and scientific community in a network virtually dedicated to computer scientists: that advantage derives from the widespread usability in other disciplines as well of the understanding of the algorithmic process being developed by computer scientists. Through the fostering of collaboration among scattered computer scientists interested in these problems, the development of such algorithms as would serve research, and thus teaching, in many other disciplines could be hastened. The availability of these results over a network serving computer scientists might make them in many instances, much more immediately accessible to other faculty in schools, colleges, and universities, as well as to the computer scientists themselves.

Complex computer systems are, of course, sufficiently subtle to be interesting as objects of study; the availability of a network also would contribute to opportunities for many more computer science teachers to study and teach computer systems at their most complex--which is to say when systems of whatever complexity are themselves only parts of a larger network.

One way in which computer scientists might be expected to put a virtual network to good use would be in conjunction with various types of non-numeric computing. That is an aspect of computing now underrepresented in the computer science curricula of schools, colleges, and universities. The growth of non-numeric computing is felt to be not only a development of quantitative significance, but one offering attractive scientific opportunities as well. Advanced symbol processing and artificial intelligence activities are classic instances of research areas, and teaching areas, requiring special and expensive capabilities; they are, then, natural candidates for inclusion on a computer science network. The problems in storing and analysing the information in motion pictures, for example, constitutes a stupendous task, for which the largest scale memories and the cleverest pattern perception routines will prove necessary. The excitement and accomplishment in such tasks can be shared when undertaken in a network environment. And we know that today's students are, proportionately, less print-media-oriented, and might especially relish an opportunity to learn from observing their computer science teachers addressing this particular set of problems.

All the varied problems that need to be researched in order to give us the user-primacy networking to be discussed subsequently--where user primacy is a synonym for educator-primacy or scientist-primacy, in this context--could be adided by the boot-strapping participation of computer scientists working over a network. That would be true, for instance, with respect to the solution of software problems specific to the needs of certain functional types of computing. Collaborative efforts over a network between computer scientists and specialists in these other disciplines is obviously a very desirable arrangement to facilitate.

The ARPANET was concerned with the interfaces between disparate computers, primarily. Now our concerns must be heavily with the interfaces with disparate users, that is to say, in part, with another type of software problem. One phase of what I am referring to here is analogous to what ARPA calls 'agentry.' That is the need to develop subtle software to stand between the user and the progressivley more complex software structures which are now emergent.

Among the kinds of research efforts into which computer scientists might enter collaboratively over a network would be basic research on program structures, program verification, and the syntax and semantics of programming languages; there are immense economic stakes in the mechanization of the software generation and perfection processes. Collaborative efforts in working on them could result in great savings. A network to serve computer scientists could be looked at as a distributed laboratory within which to conduct experimental studies. The transformation of the ARPA network into the DCAnetwork may be taken to heighten this need for a virtual computer science network.

In _Language Research and the Computer_ (1972; published at The University of Kansas, and now available through the National Technical Information Center), Sally Sedelow and I urged the design of total computer configurations to serve language (symbolic behavior) researchers--starting with user needs and working back from the software implied by an ideal human interface to, eventually, the hardware properties, rather than proceeding in the conventional way, in the opposite direction. Work on the automation of the computer system design process, starting with user specification, represents powerful methodology for systematizing and strengthening that process. Language-directed computer system design and other related activities also constitute a notable instance where a virtual network for computer science itself might be used as a research medium within which to improve the essential processes of computer science proper, including the design of what we are here calling 'full systems.' Such research could make a reality of an ideal often expressed: designing software and hardware together so that operating systems, compilers, and the like are parts of a whole, rather than oddly matched components in a forced ensemble. The history of forced matches of system elements which had evolved along incompatible trajectories is an implicit testimonial to one major need for networks. With larger systems and hierarchical programming efforts that need will be further accentuated.

The general improvement of software quality is contingent upon various efforts at collaboration and coordination, not least of all those involved in transmitting, often best done over a network, sets of programs to validation sites. Any classic area of computer science such as graph theory, and its applications, and any comparatively newly emergent area attractive to many researchers, such as complexity theory, may be a fit research focus for utilizing a network. Some parts of computer/information science, such as information systems studies, would profit immensely from enabling students to have access to a richness of structural detail, in this instance in large, operational information structures; that way students would not be limited in their understanding of what can be done through studying only 'toy' examples. A number of topics that are of very recent development as foci of attention, such as new memory devices, extremely large data bases, and intelligent terminals are all research domains in which people might wish to work over a network.

It is also true that there are certain interface subjects on which computer scientists and their students might choose to work using a network--including social interface problems with a high student 'values' salience. Examples could include the implications for the design of computer network systems themselves of freedom of information legislation, privacy ideals, and data security issues, now all subjects of generally heightened attention; other examples would be the use of modelling and simulation in areas of national need, such as with energy and the industrialization of the housing industry and construction more generally. Related in various ways to these issues is the applications area of electronic funds transfer. There, too, we have a network-spanning phenomenon which might well be studied over a network--and one which most probably will deeply penetrate the lives and work-habits of our students in ways as yet unimagined by us.

The hardware of computers could be another fit subject for research conducted in the network mode, even though cheaper powerful components also imply a resurgence of localized research options. What may be true here for some aspects of computer architectonics also may hold for certain specific components, such as special purpose microprocessors. Just as structured programming is concerned with a technology of collaboration which could use a network in the control of software production, so too might we look to structured hardware design--not to mention total system design--as a process that could be conducted on a networked basis.

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In general, apart from special minicomputer installations in particular laboratories, a scientist today--and, a fortiori, a teacher--is usually confronted with existing configurations of hardware on his campus as a 'given.' The scientist is characteristically expected to adapt himself to the situation on his campus with respect to both hardware and software capabilities. To be sure, there is some give and take, with the more vigorous and prestigious scientists on any given campus likely to be able to achieve certain special consideration, especially if they attract heavy outside funding. Nonetheless, most scientists have to adapt themselves to the existing hardware and software (unless they are prepared to make dysfunctionally extraordinary exertions), rather than having available to them capabilities specifically designed with their computing requirements as the overriding criteria. Further, the existing systems which any user has to adapt to is not by design a 'full system.' That is to say, certain sub-systems have been worked out in some measure scientifically, but other components represent particular stages in a haphazard evolution. By some standards what the scientist and teacher interact with is, as a whole, not a true system, not a 'full system.'

The emphasis in scientist-primacy or educator-primacy networked computing is to bring about the research needed to allow us to start an optimizing, full-system design process from the computational needs of a set of users, where the membership of the set is determined by comparabilities in their computational requirements. Starting with the requirements for any given class of users, we are then interested in the knowledge needed to provide such users with at least virtual network access to precisely what they require by their own definition. One would not start from existing hardware necessarily, nor from existing software necessarily, nor from existing commitments to a computer center arrangement. Rather, one would start from an identifiable set of user scientists, teachers, and students, and their specification of their needs.

In one way of breaking out some of the content relative to these goals, we could here look at--had we the time--some of the needs that are already coming to attention that are specific to particular classes of academic computing. In no particular order, I will list some of the groups from which there is evidence of grassroots concern to specify the research necessarily anterior to a satisfactory meeting of their computing needs on a networked basis. It does not require any elaboration at this point to make it evident that the situation of computer scientists themselves is analogous in this respect to teachers and scientists in other disciplines. Some scientific disciplines and specializations in which there is some sense of emergent network requirements include:

psychology;

the atmospheric sciences, including climate dynamics;

survey research, as a subspecialty within political science, sociology, and social psychology;

economics;

systematics and ecology;

human biology and the medical sciences;

oceanography (both independently and as one of the fluid sciences along with meteorology, etc.);

physical measurements research;

psychiatry, and general medical diagnostics;

language research;

chemistry;

public administration research (urban);

public administration research (higher education);

applied mathematics.

Although they are not precisely in parallel with the specialties listed above, we might also make some mention of special problems and opportunities associated with computer networks for libraries and for museums.

For something in the way of a fuller elaboration of the research needed in computer networking for a particular subject-area, in this case psychology, I'll here (owing to limitations of time and space) simply refer you to my article on "Some Implications of Computer Networks for Psychology," to appear in a few weeks in Behavioral Research Methods and Instrumentation. And for access to a comprehensive sampling of the systems literature for the sort of computer networking solutions proposed in this paper, you might consult my bibliography which is Volume V of Computer Studies in the Humanities and Verbal Behavior, recently distributed by Mouton & Co., the publishers in The Hague.

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In this section of "Research on Network Environments for Educational Data Systems," we take a different cross sectional cut of the total research and prospective research activity. This cut is largely orthogonal to that taken when we look at the requirements of a particular science subject. In that case we look at research on networking from the perspective of types of computing. In this present perspective, by contrast, we scan for the various aspects of any total system to provide network capability. In the former case the emphasis is upon what it takes to produce the knowledge for an effective educator primacy or scientist-primacy virtual network for some particular type of teaching and research, while in this section we concentrate on what it takes to provide full system network knowledge, not explicity attending to the differentiae among such full system networks but rather to the properties they must all share.

Large engineering systems such as those designed by NASA provide one of the important sources of insight into what is required to develop a full system capability for the use of networked computers for academic purposes. Behind the ability to design and make operational each subsystem with a man-machine space system there lies in varying depth, scientific knowledge of the components which have been engineered into working systems. Similarly here, although a computer network is far from so dramatic a man-machine system as a space vehicle in operation, increasingly we realize the importance of comprehensive knowledge in depth with reference not only to the totality of components making up a full system networking capability but also for the integrative properties of such systems as wholes. It can be argued that many systems (and notably many information retrieval systems) with a large computer component have not worked as well as was promised because the design was not systemic--because important subsystems were not understood in themselves and also in their mutual relationships with others. Too much of the total understanding was left to the vagaries of traditional lore, or even without any effective explicit attention.

It is unnecessary here to recapitulate in any detail the components of a total stand-alone computer configuration when seen in man-machine systems perspective. But whatever is needed in the way of knowledge for comprehending a single, computer-based system may need to be known at a scaled-up level when a large network of such single computer systems (now subsystems) is to be well understood. Here, as elsewhere, substantial differences in scale produce effects requiring fresh, independent investigation. Thus we have both questions traditional to computer science to examine in a new way when there is a shift in scale, as well as entirely new systemic features to explore. The gross categories appropriate to our understanding of these networks systemically would include the traditional elements: hardware, software, communication, user interface, application specialization, social and organizational dimensions, and total system integration.

It is primarily with reference to applications foci that a full system understanding of networked computing incorporates the kinds of research discussed above with reference to scientist or educator primacy networked computing research.

One type of research here is concerned with the dynamics of computer network data communications. Computer networks are seen as differing from certain other sorts of networks that have been better studied and understood , such as the control of the flow of physical entities, for the fact that the system under control and the communication netowrk used by the controller are one and the same. Research needs to be focussed on developing a theory of protocol or overhead requirements for such purposes as the identification and destination of messages for error control and for recovery from node and link malfunctionings, while additional effort is devoted to the utilization of that protocol information in algorithms to be utilized in such routing and recovery.

Another area of research of interest to various investigators has to do with operating system requirements specific to network environments, including distributed operating systems software. As to processing activities on networks, there is interest in the scheduling of partially ordered tasks, the approximate analysis for realistic queueing models of networks, and optimalities in networking configuration as a function of coasts and response time, as well as in aspects of reliability in networks.

A further kind of research work involves the measuring of the experience of particular classes of users with reference to the resources of the total network. That facet of systems research would give us detailed information more specifically applicable to the experience of sets of users than the network measurement activities which have been carried out over the former ARPANET.

As a further aspect of the communications research needed to give us full system knowledge we might point to studies bearing on alternative communication options for exchange between computers. Satellite communication possibilities offer one such option to explore. As network use rates significantly increase, then the kinds of problems we may expect to encounter will change somewhat in character as well, or at least may do so. Communication to network nodes from mobile sites may also pose some fresh problems in routing.

The distribution of data bases for any broad set of uses will become increasingly commonplace. We may expect the increased use of intelligent terminals and very high powered minicomputers to generate an increased use of data bases in complex ways. The combination of increased complexity in the use made of any given data base combined with access to many data bases in some coherent fashion over a network should motivate us to be interested in studies of distributed data bases.

Some investigators feel that logic for access to information in data bases is not now well enough understood. It is the conviction of some that the theory of indexing needs to be substantially reworked in a fashion adapted to the needs peculiar to the scale of very large distributed data bases, which future networks will confront. The recent ARPA initiative wih respect to very large data bases will no doubt result in marked shifts in the off-the-shelf technology available in, say, a decade or two. Specifically with reference to large information systems, we find evidence from those highly experienced in their use that much more needs to be done to render them comfortable to use. That is especially true in the perspective of a network, where numbers and types of data bases accessible, as well as the volume of the use of them, may be expected to rise very substantially. It is, for example, a long-standing complaint of users of social science data that the introduction of the computer has tended to reduce the effective control over the research process by senior investigators. This contention has been enunciated for at least a decade, for example in the proceedings of the MIT conference on the simulation of large-scale social systems edited by James Beshers. The problem grows more acute. And one aspect of the solution to it involves research on how to automate the process of keeping track of what is done to the data points which are stored in an information system. The aspiration would be for a system that kept track for the benefit of any user, notably including senior investigators, of the various steps taken in the reduction and transformation of data for his purposes. Again, making such processes explicit and then also available to the investigator more explicit evidence as to what various computer specialists and applied mathematicians have done to the data.

In the social sciences particularly there is at present a concern to make the individual disciplines more effectively cumulative. This type of research, where provision is being worked out for the automatic recording of the details of the reduction and transformation of data, should contribute to making it possible to achieve greater cumulativeness in the disciplines to which it is applied. Collaborative effort is markedly facilitated when any given scientific collaborator is able to know thoroughly what has been done with the information which he would himself use that others have contributed to the gathering and analysis of.

Repeatedly the question arises of what can be done and what should be done by machines and what by humans in case of man-machine interaction. There is a need for general findings, along with the solutions to particular types of cases. Both human factors psychologists and engineers are interested in these issues, including the developments of methodology to facilitate the effective allocation of tasks between men and machines where creativity enhancement is a critical consideration.

In those instances where the character of the partitioning of tasks implies new options as to which communication modalities to use in making computer networks function, it would be useful to study the trade-offs, economic and otherwise, among the various types of communication--person to person, machine to machine, person to machine, and machine to machine. In this domain there could be research projects which are close to the edge of current knowledge, and also on rather exotic options, such as the use of the tactile sense in communication.

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The genius of von Neumann and Turing not only in ideas achieving their realization in computer architecture, but also in envisioning possibilities for abstract machines as analytical devices becomes ever more impressive with the passing decades, as new achievements are attained while building on those basic ideas. For the past several decades there has been a growing interest in the use of graph theory in the study of human interaction, as with cognitive balance theory (as originally stated by Fritze Heider), with its subsequent elaboration, and with cognitive dissonance theory. Partly owing to the possibilities opened up by the contemporary power of computing there is at present an immense growth of interest and competnece in this kind of work.

The Mathematical Social Science Board recently sponsored an interantional meeting of some importance on precisely that topic. The importance of graph-theoretic approaches to the characterization of the social or human component in a total network system is very great. After a drought of extraordinary duration as to relevant ways for social scientists to study the structuring of complex interaction among humans, it is a happy fact that a notation and methodology are now emerging appropriate to application for the study of the social networks which are a part of the total system of a computer network. For analytical power and theory integration it is also very fortunate that some of these basic notions that have proved useful in studying machines and programs are now proving to be useful in the study of human behavior related to hardware and software.

That opens up the prospect--albeit a vista of great length--of one body of theory which can be used in the analysis of men, machines, and information systems, as well as communication functions, taking place in a full system network. And within that prospect we may expect to have, also, a view of a markedly enhanced understanding of the significant detail as to how people as students actually learn about--<u>and through</u>--computer-based knowledge networks.

OTIS: INFORMATION SYSTEM FOR OREGON EDUCATORS; INSTRUCTIONAL COMPUTING FOR OREGON STUDENTS

Dussenberry, Robert L.
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Oregon Total Information System

ABSTRACT: Oregon Total Information System (OTIS) offers a full range of on-line computer services statewide to Oregon public schools. Business student management, and instructional services are provided. There are 220 leased data lines to 70 school districts for on-line input and inquiry. Started in 1968 with ESEA Title III funds, OTIS is now completely user-funded. A user-constituted advisory committee and district-level coordinators provide communications channels between OTIS and the user districts. OTIS operates with a mix of vendor hardware. The teleprocessing network features dual functioning of lines and terminals in switching between the administrative and instructional services computers by use of OTIS developed software. A Query language to search user files is among the features of the OTIS capability.

In the mid-sixties, Oregon had no large and comprehensive educational data processing system. In 1966 a government planning grant initiated the project which was to become Oregon Total Information System; in May, 1968, OTIS began providing data processing services from its central location in Eugene, Oregon, primarily to schools in the surrounding county (Lane).

Today OTIS has become a successful, completely user funded cooperative of school districts administered by the Lane County Intermediate Education District (IED). The Lane IED Superintendent is Dr. William C. Jones; OTIS' Director is Robert L. Dusenberry. OTIS serves disparate school systems (elementary, secondary, some community colleges) and educational agencies throughout Oregon with administrative and instructional services.

OTIS' systems are designed for its users; its services are utilized efficiently and creatively by school personnel, using terminals at their own buildings, without the necessity of any more data processing knowledge than that which they can get from manuals supplied by OTIS. Clerks and business officers input and update information to their files in the financial accounting, payroll, personnel and inventory systems, and reports are generated from their input. Students are enrolled, graded, and scheduled by OTIS: attendance reports are run from terminal input, and inquiry capabilities make the information in individual files always immediately available. OTIS' on-line Query System allows the user to create his own reports: using a Query manual of statements, he can search files and extract pertinent facts and so adapt reports to conform to his specifications. Students can learn BASIC, a programming language, write their own programs, store them and rerun them as often as they wish. Instructional media center personnel can use a terminal transaction to book materials, and the booking is immediately confirmed for the requested date, or if it is not available, the user is informed of the next date it will be.

Through the teleprocessing network, schools can access the IBM S/360 model 50 with Ampex add-on fast core, which holds administrative services files or the three Hewlett-Packard 2000F computers used for instructional services, and can be switched from one machine to another by the GTE IS1101. Administrative services are maintained and processed on the IBM 360 by the General Education Management System (GEMS), an OTIS software system of integrated data files with two sets of control tables and a set of generalized processing programs. GEMS makes it possible for each user to define and maintain only the data storage and processing that he requires and to change his definitions as his needs for information change.

OTIS SERVICES - Administrative

Have OTIS' services grown and become increasingly sophisticated because increasing user needs have made it necessary, or has usage of the system grown because new and more comprehensive services have become available? An unanswerable question. Perhaps OTIS' success is due to the great need recognized by Oregon school personnel for a large data processing system, or perhaps OTIS' success is due in large part to its creative staff members, who have developed original software and many modifications to existing software during the establishment and expansion of OTIS' many services.

Student Services

The emphasis of OTIS' first year of operation (1968-69) was on student services. Some software had been developed by Lane Intermediate Education

District personnel, some from vendors. The three main working systems were testing, enrollment, and mark reporting. The attendance system, totally developed at OTIS, was in its formative stages, and the completed system was debugged and usable by 1971.

Educational Coordinates' (EC) scheduling system and the Student Scheduling System (3S) are both used at OTIS. In 1968, OTIS gathered data and sent it to EC for input; in 1969, OTIS acquired EC's library of software and could do all the scheduling in-house. A loader program from IBM started the 3S system, which has been modified extensively. OTIS staff developed an arena scheduling system which was implemented in 1971. As scheduling needs have changed so have systems. In the last five years there has been a dramatic move away from structured, standard scheduling, and OTIS has modified its systems to allow for a large variance in scheduling applications.

By the end of 1972, the Student Services system was functional and completely implemented. The systems have since evolved to allow great flexibility in types of output. Student body rosters or mailing labels, for example, can be printed alpha by grade, by teacher, by sex, etc. Labels for tenth grade boys or a list of ninth grade members of the band can be generated easily.

A new system at OTIS is a automated record keeping system developed to accomodate Oregon's high school graduation requirements. The State Department of Education has directed that certain requirements be met by students in Oregon schools: In order to graduate from high school, a student must prove minimum survival level competencies in three general area - personal development, social responsibility and vocational education. "minimum survival level competencies" have been described by an Oregon educator as "what you have to know in order not to be taken too badly or too often". Since each district develops and evaluates its own competency levels, the record keeping system has had to be extremely flexible to allow for large individual user needs. The system offers individual district options on definitions of competencies, multiple-check status of competencies, types of input, and types of reports. This year, three districts of varying sizes and problems are piloting the system.

Business Services

Business Services provided access to a payroll and a fiscal system its first year (1968), and to an inventory system, which was used by only four districts.

Payroll information was input by batch processing at the computer center [now it is completely on-line; i.e., district clerks input all the information needed from their own terminals], and processing of both payroll and fiscal report runs was set up on demand rather than on a schedule. Processing was slow, and OTIS staff members spent many extra hours keeping the system running smoothly. In the 1975-76 school year, 65 districts use the system, and nightly processing runs are scheduled. In 1969, on occasion, one job could take fourteen hours. Now the total run (processing for 56 districts) will take 1/2 to 1 1/2 hours to process.

The Business Services systems have been completely designed by OTIS staff members in conjunction with users. This year, services include fiscal, payroll, personnel, inventory and cafeteria inventory accounting systems, which produce over 50 different kinds of reports. Query capabilities are also available.

The newest application is the processing system developed to accomodate Handbook II (revised), an accounting system established by the federal government for school districts. All schools must use the new system by the 1976-77 school year, and the OTIS system is now 90% complete.

In 1972-73, a pilot district used the Handbook II (revised) accounting system, and with modifications OTIS' processing system is now used in 20 districts. All OTIS Business Services user districts will be ready to use Handbook II (revised) in 1976-77.

Query System

The Query System has been under development since the fall of 1968. The original system, conceived by an IBM analyst, was slow and inflexible, with little choice in sort order. Priority was given to increasing the speed of the system, finding means of developing the most useable sorted output, and allowing the user to specify what sort order he wished. As data becomes large, the sort order is more important; a non-alphabetical list of all boys in a 1000 student school would have been unwieldy and probably unusable. For the last two years, the Query System has been dependable, efficient, and is on-line. The user can enter his query via terminal and will get his report back on the terminal the same day, sometimes almost immediately.

With Query, OTIS users can create their own reports, designed by them for their unique needs. In using Query for exception reporting, an OTIS user can meet information needs not provided by the standard reports. Query requests are input directly from building terminals, and the output is sent by courier service, though the output is also commonly printed out on the users terminal.

OTIS SERVICES -- Instructional

In 1969 OTIS instituted an instructional computing system called RAX (Remote Access Computing System). Users could access it for only two hours on Tuesday and Thursday, from 5-7 p.m., when teleprocessing was down, because it needed to take over the whole IBM 360 system to work. Few terminals used the system, and it was not very successful in terms of convenience, so in 1971 ITF (Interactive Terminal Facility) was begun. It could be run during the day and offered problem solving and a method of teaching programming to students. However, the ITF system caused problems: it often interfered with teleprocessing and brought the system down, and the turnaround time was extremely slow. There were few canned programs available, and users found the system too limited and undependable.

In 1972, OTIS acquired an HP 2000F computer for instructional use, and a GTE IS1101 to provide interface between the IBM system and the HP. Thus administrative services users can also use the instructional system from the same terminal. The system has 32 ports available for use 24 hours per day, and users pay $3.00 per terminal hour for its use. During the fall of 1975, OTIS acquired another HP 2000F with option 205 to accomodate increased instructional use. A third machine was installed this fall. OTIS' instructional computing system serves 42 districts, who used approximately 47,000 terminal hours last year.

Instructional Services currently available include the Computer Related Instruction System (CRIS), the Occupational Information Access System (OIAS) and the OTIS Automated Library System (OALS). CRIS and OIAS use the Hewlett-Packards, OALS uses the IBM GEMS system.

OALS' booking and scheduling system, a service contracted by the Lane IED - Instructional Media Center (IMC), and available to Lane County teachers, students and librarians, schedules over 12,000 discrete print and non-print items for use in schools. The system is on-line and produces operation and usage reports as needed.

The non-print evaluation system is also used in Lane County. Teachers preview and code evaluations of IMC materials in areas of their specialty and evaluation reports are available for the IED to use in the decision-making process concerning acquisitions. A report can be sent to schools which lists items recommended as useful in different areas, as well as those deemed not useful. Pricing figures and vendors' names are listed.

The book catalog system, used by several county IED's, manipulates input of bibliographic data, subject headings, annotative information and call numbers to make book catalogs, replacing much of the labor of manual card catalog systems.

Literature searches of current educational reports, monographs and journal entries, called ERIC searches, are available to users through the OALS system. OTIS processes nearly 100 searches each month.

CRIS provides instructional computing for all areas of a school's curriculum. CRIS users access over 400 canned programs, such as drill and practice in math, reading and language arts, simulations and games. The system offers problem solving in BASIC for students to learn programming. Computer assisted instruction (CAI) in reading, mathematics and language arts on the elementary level is being piloted this year at Blossum Gulch Elementary School in Coos Bay and plans are underway for a program at Chemawa Indian School.

Software from the Computer Curriculum Corporation (CCC) is used for CAI at the elementary school. Eight terminals at Blossum Gulch are connected to OTIS, and a reading project began this fall. 100 students per day use the system.

CAI is an "exchange of information between computer and student," according to CCC literature. It is aimed at students with a low level of performance; the curriculum for each student "will be at a level appropriate to his achievement in each learning area" so each student has the opportunity to learn at his own level and his own speed. The program provides remedial assistance in the form of progressive drill and practice.

There are advantages to this type of reading and language arts program for remedial students. There is no discipline involved, no teacher disapproval, no necessity to perform for others, and wrong answers won't hurt. The student will have nothing to lose, and it might even be fun.

Chemawa Indian School, an alternative school administered under the Bureau of Indian Affairs, is operating a large program in computer assisted instruction in reading and language arts. Chemawa is an off-reservation boarding school for dropouts and students expelled from other schools, located in Salem, Oregon, with students from Oregon, Washington, Idaho and Alaska. Counseling and vocational training are emphasized, and students are given a chance to acquire skills they have missed in the formal educational environment.

Chemawa students have not performed well in reading and language arts examinations; according to Chemawa administration, causes for this include lack of time for sufficient individualized instruction and low student motivation caused by past educational experiences. CAI will give individual drill every day, and will be an entirely different educational experience for the students. The project involves the use of 32 terminals, another HP 2000F at OTIS, and students will use CAI during the day and evening.

OIAS is a computerized vocational counseling program. Through a questionnaire, a student answers questions and states preferences, then possible occupations are presented which correspond to the personality profile suggested by the questionnaire results. Detailed information on each occupation is produced upon demand. One can ask for a job abstract, which describes job duties, working conditions, salary range, turnover rates, qualifications for the job, employment prospects and other pertinent facts. Qualitative information is included in this job abstract; for example, the job description for college teacher states that one must have the ability to work with abstract concepts, have self-discipline and good judgment.

Through the INFO files one can also get a bibliography of occupational books, find out how people prepare for the occupation, get a list of courses, degrees and schools for an education or training program, compare the services and costs of schools and get the names of people for personal discussion about the occupations.

The vocational counseling program is jointly administered by OTIS and the Career Information

System, an interagency consortium providing vocational information, located at the University of Oregon.

OTIS has grown and changed considerably since 1968. Its charges have lowered from $8.80 per student for complete administrative services to $7.00. The student base of user districts and educational agencies has raised from 65,000 to 150,000, from 28 school districts to 72. OTIS is financially stable and operationally sophisticated, and its services become constantly more varied and complex.

To offer complex services, one must balance them with a sophisticated data base - an education process is continually necessary to train new district or school employees and explain new services so they can be efficiently and productively used. To facilitate this balance, OTIS has a knowledgeable field service staff and a system of data processing coordinators.

Cooperation and communication between users and OTIS are important, to keep misunderstandings down and user operations running smoothly. The data processing coordinators work as liaison between districts and OTIS. Each district's coordinator assists in training of users and communication of district desires and needs. Coordinators meet periodically to discuss problems, new services and procedures.

OTIS' field service staff, each person an expert in a specific service and with a general working knowledge of all services, is a direct communication line between user and OTIS. When a school comes on the OTIS data processing system, a representative of each service area shows him how and why the system works. When districts need help, or hire new personnel, field service staff people are ready to smooth the way.

Users from fourteen counties in Oregon are served by OTIS through over 200 terminals. Representatives from county and district educational organizations throughout the state make up OTIS' Advisory Committee, which is consulted on important policy matters and system development.

In terms of upgrading quality and furthering equality of education, OTIS' impact on Oregon school systems has been great. Clerical duties are minimized at school and district level; educators have more time for students, and students have access to instructional computing systems. A district with 200 students can get the same types of reports and information as a large district, with more students and a larger tax base. Only a few districts could afford to provide the services OTIS can provide; through the on-line teleprocessing system all school districts have an equal opportunity to avail themselves of data processing and instructional services.

OTIS HARDWARE

Computers

1 IBM S/360 model 50 with Ampex add-on fast core
1 GTE IS1101 Computer
3 2000F Hewlett-Packard Computers

Input/Output Devices

4 2400 Series Magnetic Tape Units
2 2314 Direct Access Storage Facilities
1 2321 Data Cell Drive, Model 1
1 2540 Card Read Punch
1 1403 Printer, Model N1
10 Double Density Disk Drives

Supported Terminals

Teletype 33
Teletype 38
Hazeltine 2000/1200/1000

OREGON TOTAL INFORMATION SYSTEM
1200 Highway 99 North, Eugene, OR 97402
Robert L. Dusenberry, Director

DEVELOPING A METRO

COMPUTER CONSORTIUM:

PROMISES AND PROBLEMS

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ABSTRACT: Providing for joint computer services in five school districts with a combined population of 150,000 students is a demanding, challenging problem. To effect this consortium approach, each of the five Twin City area districts, already with sophisticated EDP, must analyze current systems and project its anticipated needs to fit the new, regional METRO II effort. In turn Metro II must align with the statewide MECC (Minnesota Educational Computing Consortium) design. Problems with equipment, software and people can be solved and resolved, but not without some obvious difficulty. However, changing technologies and more sophisticated MIS would seem to preclude the founding dictum: equal or better service for no greater cost. Greater cost may be justified if more cost-effective utilization of computerized MIS occurs in administrative decision-making and services are enhanced. This appears to be happening with Metro II.

Metro-II, a regional, metropolitan computer consortium, began in 1972 as a joint powers agreement resulting from some enabling state legislation in Minnesota. Aware of the considerable tax dollars being expended for hardware and diverse computer systems being developed by various state and local governments and agencies, the Minnesota legislature passed a law which, in effect, consolidated educational computer services at all levels: elementary, secondary, vocational (ESV), state college system and the university. To appreciate the extent of the problem to be solved, one must realize that just prior to the consolidating legislation, dozens of computers, software systems, applications and reporting systems were operational with a multitude of applications. Uses ranged from instruction (CAI and CMI) and pure research to a wide range of administrative applications.

Computing machines ranged in type from analog to digital, in size from the desk top to special purpose, and on to large, complex timesharing systems. Informational and organizational reports were generated internally and externally for all these educational systems. Operating systems were revised and expanded frequently. Computing people in education were, in effect, mass producing the invention of the wheel. Developmental costs were incurred by school districts for producing essentially identical student systems, for creating and maintaining equivalent instructional program libraries and a host of other essentially isomorphic systems. For example, CAI libraries had near identical versions of arithmetic drill and practice as well as the latest updated version of Star Trek incorporating Supreme Grand Master attack strategies. Where did it all lead? We found increasingly complex systems and machines, in their replication, costing the taxpayer exponentially greater dollars. Probably for the wrong reasons and a lot later than it should have occurred, legislators decided to put on the "disk brakes"!

Actually, legislators, who in the final analysis had to approve funds for much of the statewide computing operation, at least indirectly, were beginning to feel the pinch. More directly, they felt, and rightly so, the need for a more comprehensive, uniform information reporting system. While many educational enrollments declined, requested budgets increased. Hence the need for better information for better decisions at all levels, including the legislators who must appropriate the dollars.

In 1970, the Governor's Task Force recommended comprehensive statewide information networks. In 1972, Metro-II was conceived. "Metro" identified the metropolitan nature of the involved school districts. The "II" referred to the fact that there existed already another metropolitan educational computer network--TIES. TIES had served a large number of Minnesota school districts, mostly metropolitan, with a total student population of nearly 250,000 students since the 1960s. But the thrust of Metro II was different. These 5 districts with about 150,000 students, were already relatively sophisticated in their computer applications. They differed however in certain applications. St. Paul had a rather comprehensive student and POBAS system. Minneapolis already was providing extensive CAI applications. Mounds View possessed an exemplary instructional management system. Robbinsdale had developed a comprehensive K-12 student system incorporating, academic, health, transcript and extensive extra-curricular information. District 916, clearly, was in to extensive vocational applications in EDP.

To make such districts fit consortium-wise from an MIS viewpoint, perhaps almost seems imMIScible. But to the chagrin of the "nay-sayers" and to the credit of the "can-doers", it appears that it will indeed function and, eventually, function most effectively.

Using a systems approach adopted by the State of Minnesota called PRIDE, each of the five districts first listed, in some detail, all present applications as well as future computer directions. Considerable man-hours were expended during this phase documenting current systems operations, meeting jointly to discuss related problems and enlisting positive support from staff. Many feared or opposed the regional consortium approach during this period, adopting a "head-in-the-sand" approach: if we don't look, maybe it will go away! Of course, this strategy seldom works. It only makes one more vulnerable to attack from the posterior.

After considerable stressing and straining, a complete list of "needed-nows" and "needed-laters" was produced by each district. The systems consultants involved, although generally most helpful, somehow managed to make the matters worse by keypunching this comprehensive list of needs and then computer-printing it for return for check and sign-off. However, they neglected to order or identify the needs beyond a Watsonian elementary manner, and each district searched through forty pages of randomized documented needs analysis to see if their artifacts were earthed somewhere.

Metro-II, in late 1975, began to feel the positive effects of leadership when its new Executive Director was named. Not long afterward, MECC, the parent statewide organization hired a full time Executive Director also. Although MECC's chief concern at the time was taming a Univac 1110 to provide CAI services, the addition of stable, responsible leadership there had a positive effect on all co-operative computing services.

Each district currently is making satisfactory progress toward completing various systems phases: personnel-payroll and student are progressing most rapidly. Financial and instructional management also are moving toward time-line phases. Greater difficulty has been encountered in the so-called Facilities-Other area: one man's miscellany is another man's mission. For example: while busing may be exceedingly complex and horrendous in one district, in another, the regularity of streets, and consistency of enrollment policies beget total computer solution. In any event it is expected and hoped that by 1978, designing, developing, testing, re-testing, piloting and parallel operation will cease and Metro II will be ready to go, fully operational.

The presently-adopted computer configuration calls for a central, host computer site housing a Burroughs 6700, with 5 satellite operations (B 1700), one in each of the five districts. Fully converting each of the present non-Burrough's users to the new systems will be a problem located below the water-line of the iceberg. For the largest part of the conversion problem would seem to be the retraining and re-education effort: all the users--and particularly the non-technical users. Each district has clerks and aides, secretaries, teachers, counselors, psychologists, researchers, principals, district office personnel, school boards and the public--who, in varying degrees, are producers and consumers of computerized information. All are involved with the legitimate, computerized need-to-know. The consortium approach will produce different effects for all those involved.

To provide an example of just part of the problem for one of the users consider some of the first phase requirements as submitted by the districts shown in Figure 1.

Figure 1

METRO-II NEEDS ANALYSIS

SCHEDULING & MARK REPORTING

Section I

A. SCHEDULING

1. Provide capability of scheduling elementary schools.
2. Provide for scheduling students district-wide, e.g., scheduling of classes outside of home school.
3. Provide capability of registering and scheduling students in Community schools.
4. Provide that student request file and master schedule be on-line for update processing.
5. Provide capability to schedule on demand any number of students, even after the bulk of students have been scheduled.
6. Provide capability of scheduling on-line on demand during prime time.
7. Provide capability of on-line course tally, matrix and segment matrix (one course against all other courses).
8. Provide capability of on-line independent study tally (open mod availability).
9. Provide capability to edit current courses, requests and credits earned against past course history and district requirements.
10. Provide capability of purging student data base to provide user with tallies of students not having completed specified required courses to assist in teacher staffing and master schedule building.
11. Provide master schedule builder.
12. Provide capability to integrate master schedules for diverse programs (e.g., learning center, individual schools evening high school).
13. Provide capability of scheduling a student's courses based on prerequisites within the school year, i.e., schedule

Math I before Math II.

B. MARK REPORTING

1. Provide capability of grade reporting for modular programmed classes with 1 grade and attendance per subject.
2. Provide capability to print assessment and evaluation statement type elementary report card from codes maintained on the data base.
3. Provide capability of having teacher comments on the grade reports and additional grading methods.
4. Provide capability of recording and reporting community school attendance, grade reporting, and credits earned.
5. Provide capability for city wide mark reporting students in more than 1 building.
6. Provide capability of each district using its own type of grade reporting format, forms, and notations.
7. Provide capability of updating courses and grades on-line during report card cycle.

CENSUS & TRANSPORTATION

Section II

A. CENSUS

1. Provide capability of maintaining student records via a family number and generating complete family lists.
2. Provide on-line capability to call for census enumerator forms printed for selected census addresses.
3. Provide capability of preparing statistical reports by family, including preschool students.
4. Provide capability of having additional statistical correlations.
5. Provide capability of reporting and recording door to door census, retaining records thru age 21.
6. Provide capability of merging school census with government census.

B. TRANSPORTATION

1. Provide ability to prepare statistical reports of pupils by census tract, by census block tract, by school, etc.
2. Provide capability of maintaining, online, a bus scheduling and routing subsystem including distance matrices.
3. Provide capability of maintaining attendance and participation records for transportation.
4. Provide capability of using street intersection nodes in transportation route scheduling.
5. Provide capability to maintain online for each census address the following:
   a. kindergarten, elementary, jr. high and sr. high school assignment codes along with distance from portal to portal.
   b. transportation eligibility and state aid eligibility codes,
6. Provide ability to identify transportation eligibility and information for various courses and programs other than normal school program (e.g., learning centers, special courses in other schools, ...).

STUDENT & ATTENDANCE

Section III

A. GENERAL

1. Generate student transcript (on demand) at school level.
2. Provide capability to maintain both community, career and adult education records.
3. Provide capability to integrate all data systems provided by MECC (both instructional and administrative).
4. Provide functional editing and updating system on-line for entire data base.
5. Enhance capability of assigning students for the next year by computer.
6. Provide capability of surveying parents by use of census records.

B. STUDENT

1. Provide free lunch eligibility lists, reports, ID cards and mailing information.
2. Provide capability to identify AFDC and Title-I and provide target area identification.
3. Provide capability of merging tuition reports and records with the student information system.
4. Utilize state ward number (G number) for identification and processing purposes for Special Services Department.

C. ATTENDANCE

1. Provide the capability of daily attendance reporting for as many calendar report periods as necessary. Include enrollment data for the reporting period. Generate school absentee lists and summary data at the end of each term and school year.
2. Provide capability of keeping records of attendance and participation in all special programs.

D. HISTORY

1. Maintain student records on students from date of first enrollment (grades, attendance, schedule of classes, programs, etc.).
2. Generate cumulative records and transcript of credits.
3. Generate master roster of students from past records to verify various aspects of

requested information.

E. SPECIAL PROGRAMS

1. Maintain Common Program Directory Information (Special Education, Federal Projects, E.S.A.A., Right to Read, etc.).
2. Provide capability of generation of the federal Title-I comparability report, (combine student, finance, and personnel information).

F. GUIDANCE

1. Provide guidance information for occupational plans, information to be tied to student's record merging student data with counseling package., (i.e., occupational plans and goals).
2. Provide the capability of a computerized vocational information system (like CVIS).

G. TEST REPORTING

1. Provide ability to scan, score, analyze and prepare reports for teacher made tests, standardized tests, computer achievement monitored tests, curriculum assessment tests, etc.
2. Provide ability to do correlations of various tests to one another.
3. Provide ability of progress monitoring of individual student on tests.
4. Provide capability of producing individual test skills profiles.
5. Provide capability of producing correlations between the grading system and testing system to include historical data.
6. Provide capability of norming all standardized tests including also criterion referencing.

H. RESEARCH

1. Prepare special transfer statistics.
2. Provide capability of using student files for needs assessment, sight count (suspensions, retentions, lunch program, graduate follow-up), and other surveys.
3. Must identify for research purposes, courses attempted but not completed from current and history data.
4. Provide a wide spectrum statistical package.

I. SUMMER SCHOOL

1. Provide capability of handling summer school - including registration, scheduling, mark reporting, attendance and transportation for elementary, secondary and special education programs.

CONCERNS

Section IV

The members of the METRO-II Needs Assessment Committee submitting their respective needs, for the statewide MIS, have also included a number of potential problems and needs. The committee feels that these concerns should be addressed by appropriate MECC personnel. These areas of concern deal with hardware capability, data volume, district resident hardware, etc.. The following list identifies the concerns which were included in the MIS needs submittal to MECC:

1. Capability for minimum turnaround of reports and data 48 hours or less.
2. Capability for back up runs on emergency basis if computer down.
3. Ability to deliver forms on a daily basis to schools.
4. Problem with all schools opening same time and data volume.
5. Scanners needed in district for edit capability.
6. Ability to provide COM services.
7. Ability to convert past microfilm records, not on computer, to on-line terminal.
8. Terminal update (file maintenance) at school and district office level. Require both CRT, card readers and printers for user.
9. Capability of compiling and executing Fortran IV for a variety of statistical reports.
10. Must have capability to handle all aspects of non-public school processing.
11. Provision for CAI-oriented program which provides explanation of data base and reports available to district personnel.
12. Capability of producing any government report.
13. On-line service request plus status of request.

Subsequent phases in development call for refinement of these needs into more precise language, and the detailed systems analysis necessary to begin the preparation for the massive programming effort. Many of the Metro II districts already are planning for telecommunications systems. This lends another dimension to the system but also more problems. In St. Paul, we currently are utilizing two CRTs in the Student Accounting Office primarily for file inquiry. Creating and modifying student records is planned for fall, 1976. Although the district is faced with declining enrollments and, therefore, dollars, it is hoped that selected schools will be utilizing telecommunications within a few years. Data can be considered truly accurate only when those who provide that data, in this case the schools, use it. Instantaneous access to and correction of student files promotes overall usage and, hence, accuracy. And of course, in the student area, where numerous internal reports are prepared to assist in decision-making and external reports are made for various local, state and federal aids and reimbursements, accurate data is critical. Since Metro II is funded by member districts as well as state contribution, the consortium has a stake in this vital area as well. Not only do district payrolls have to be on time and correct, so also do the membership foundation aid reports.

Another concern is data security. While most districts now have their own approaches to security problems, security becomes somewhat more critical in a consortium. In Minnesota, we must comply not only with a federal law on data privacy, but we are also subject to a comprehensive state law which covers all records on individuals maintained by local governments. This includes school districts. Thus, each school district has set up regulations and procedures dealing with the privacy aspects of data for their own districts; some have instigated security measures as well. In St. Paul, magnetic cards are required to enter the data processing areas. We have also developed forms, brochures and procedures to comply with the privacy laws in data collection and reporting. The present CRTs in use in our district require sophisticated identification procedures before files may be accessed. Although the temptation to illegally access files might exist in the educational sector, there does not seem to exist the more compelling security paranoias as are prevalent in the private sector. School districts do need to establish proper security measures and procedures dealing with proper collection, maintenance and release of information. But, overly elaborate and excessively costly security procedures probably are not essential in the educational domain. Our problems generally arise more from inattention than intent, carelessness than calculated plotting. In any event, Metro II will provide for data security within and between districts. It is hoped that, as an agency of state government, Metro II will assist in bringing about more consistent procedures dealing with the collecting and reporting of information. While the proverbial song-sheets do not have to be identical, they should be similar enough to provide harmony instead of cacophony. Inter-district transfer of student records, for example, should be a simple, consistent procedure to insure the smooth flow of the educational process when a student transfers from one school district to another.

A related concern is the reporting of information to the state. Metro II has taken an active role in cooperation with our State Department of Education to revise and reform, as much as possible, antiquated, pre-computer reporting systems. For example, presently, all reports submitted to the state are laboriously hand-transcribed from computer sheets to state forms. Since those state forms are essentially pre-deluvian (many not revised in several decades), much of the data needs to be massaged before it can be transcribed. Why not one reel of tape from us to them instead of reams of paper? Or, if school districts now, finally, begin to utilize the telecommunications technology widely adopted in the private sector a decade ago, there are even more efficient methods. Another problem: some years ago, state aids in Minnesota were based on Average Daily Attendance. Now those aids are determined by Average Daily Membership. Yet, school districts still are required to complete voluminous ADA figures for the annual state report. We have estimated that, in the St. Paul Schools alone, the collection, maintenance and reporting of this data costs nearly $100,000 per year. Assuming that someone, somewhere in a state cubicle reviews these esoteric figures accurate to three decimal places, is it worth the cost? Metro II is helping to get an answer to this question.

While much work has been accomplished, much yet remains to be done. Timelines call for piloting and parallel operations next year, conversion in two years. Dollars are needed; support is needed, much hard work is needed. If these essential components can be maintained, Metro II can become a functioning, effective computer services consortium. We would hope that, in a synergistic sense, the combination of our five school districts will be whole greater than the sum of the parts. If so, problems will be solved and promises will be kept. Good decisions require good information. Making such decisions is a promise to ourselves that we must keep. In that sense, problems are, instead, a true challenge to us all.

MANAGING THE LARGE SCALE INTERACTIVE INSTRUCTION NETWORK

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Coast Community College District, Costa Mesa, CA 92626

ABSTRACT. Issues and alternative approaches to planning and managing large interactive networks in an instructional environment are addressed. Large scale networks are defined as having more than seventy-five terminals used by several thousand students with several hundred author-instructors from many disciplines.

Special categories of planning and management issues addressed include:

1. Hardware - Issues relating to what kind of and which vendor's computer are appropriate for instructional networks are addressed. The impact of mini and micro-computers on instructional computing is assessed. Alternative networking techniques are presented. Communications equipment including terminals are discussed in light of economic and educational objectives.

2. Software - Alternative software environments are addressed. Operating systems, teleprocessing monitors, data base management systems, general computing languages, and author languages are defined and discussed in an educational perspective.

3. Courseware - Alternative organization and incentive models are reviewed in light of their ability to provide instructional materials on the computing network.

4. Futures - Conjecture about the educational computing network of the future are presented. Economic and technological forecasts are reviewed with appropriate deductions and inferences for education in the near and intermediate future.

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THE TIES DESIGN: AN MIS TOOL FOR EDUCATION

E. Ronald Carruth
Director of District Services

Russell E. Weitz
Director of Design & Development

MINNESOTA SCHOOL DISTRICTS DATA PROCESSING JOINT BOARD
1925 W. COUNTY RD. B2, ROSEVILLE, MN., 55113

TIES (Total Information for Educational Systems) is operated by the Minnesota School Districts Data Processing Joint Board, a consortium of fifty school districts, serving approximately 300,000 students and 50,000 employees. TIES, through an on-line integrated file structure and major application components serves the management information needs of its member school districts in a cost-effective and timely manner. The application components serve needs in the major areas of; census, student accounting, scheduling, mark reporting, attendance, payroll, personnel, finance, instructional management, instructional timesharing and research. A Generalized Extract System permits the generation of information and reports that are not part of the standard system. Data elements are updated through Visual Display Devices and Intelligent Mark/Card Readers located in the individual school districts. This places the responsibility for the integrity of the data close to the source. TIES obtains its operating funds entirely from the per student membership fee which is the same for all districts independent of size and geographic location. This encourages districts to make full use of all the varied services provided to the fullest extent.

The key to the success of TIES has been its recognition that its role is to provide services to PEOPLE in school districts through the development of the SOFTWARE necessary to meet the needs expressed by those people and to use whatever HARDWARE is appropriate and cost-effective.

THE PEOPLE SYSTEM

TIES is totally funded and governed by the Minnesota School Districts Data Processing Joint Board. The governing board of the organization is made up of two representatives from each member district and meets semi-annually.

The operational policy group is an eight member Executive Committee elected from the total Joint Board. This Committee meets monthly and is directly responsible for policies that govern the day-to-day operation of TIES. The operational control of TIES is vested in the Executive Director.

The Joint Board was formed in 1967 when twenty school districts undertook the establishment of a unique educational service called Total Information for Educational Systems (TIES). Those twenty districts enrolled 112,000 students. By mid-1976 in Minnesota TIES is producing administrative, instructional and research services for fifty member districts with near 300,000 students and 50,000 staff located in over 330 school buildings. Each district is responsible for its own integrated data base. Maintenance of the data base is achieved utilizing on-line visual display devices and intelligent mark readers. Neither distance from the central facility nor size of a district is detrimental to the service obtained. One district is 255 miles distant, another only a half mile from the TIES building located in Roseville, Minnesota. The smallest member district has an enrollment of 800 students; the largest around 32,000 students.

The structure of the TIES central staff, of some sixty individuals, has developed over the years and now there exists two distinct but interrelated groups or divisions. The District Services Division is responsible for the day-to-day provision of services to the member districts. Within this division are the Computer Operations staff, the I/O Control group and the Services Coordinators who are responsible for user-manual production, trouble shooting, in-service training and in general being available to district personnel at all times. The Design and Development Division, composed of application oriented systems analysts, software and hardware specialists, programmers and researchers is responsible for new development as well as the maintenance and enhancement of already existing systems. The Design and Development Division is advised and supported by committees composed of users from the school districts; teachers, payroll clerks, research and evaluation specialists, business managers, principals and assistant superintendents for finance, personnel officers, pupil services directors, federal program coordinators and so on. These advisory groups have the responsibility of bringing their needs to the TIES management, help design the application, monitor the necessary testing and provide feedback at each stage.

In addition each member district employs an

Information Systems Coordinator who is the day-to-day liaison between the TIES staff and the school districts. These coordinators are appointed to committees and an elected group serve as advisors to the Executive Director and Executive Committee in the area of priority setting. With few exceptions the recommendations of this group of member districts personnel are accepted as the system priorities for the TIES organization each year.

THE SOFTWARE SYSTEM

The data base is organized in logical and functional files. Physically the data within these files are stored randomly on disc. The structure is such that it provides great flexibility. It uses the "master/trailer" concept and for each master record there may be many trailers. As new applications are developed to meet expressed needs and additional data elements are identified, extension of the data base through the addition of new trailers allows flexible low-impact enhancement.

Data elements which are of a permanent or semi-permanent nature are stored in the "master record". For example each student has a "master record" in which are stored such data elements as; date of birth, school attended, current grade level, credits and honor points earned, prior attendance record, etc. The family link is also part of this record. This link is the pointer to the family master record which contains address, telephone number and other pertinent data common to all members of the same family. Thus many students, attending different schools within a district, can be linked to one family record and common data elements for these students are stored only once.

Data elements subject to regular or sporadic change (current classes attended, etc.) are stored in trailers to the student master. Free form trailers are also available to the student master to satisfy the special individual needs of districts. This free form trailer concept is particularly valuable in the research area.

Similar master/trailer structures are used throughout the TIES integrated data base. In the Personnel/Payroll System (PPS) current data relative to such items as voluntary payroll deductions, payroll distribution codes and current teaching assignments are stored in trailers to the personnel master. In the Finance/Budget and Accounting System (FBA) major expenditures accounts are stored as master records and actual individual expenditures (objects) against this account are stored as trailers.

The pivotal point of the TIES software is the File Control Program (FCP) which permits access to the data base for inquiry and/or update from both remote devices as well as application programs producing necessary reports. The File Control Program accepts requests for specific records or parts of records to be retrieved from the data base. The request is validated by FCP for correct format and also for legitimacy in terms of data security (A multi-dimensional security system is operational.). If an update is involved, the before and after update image of the record is stored on magnetic tape. This storing of before and after image of all updates to the data base provides an audit trail against hardware malfunction and even protects against disasters of significant magnitude by providing a means to recreate and restore data files.

In addition to FCP TIES has developed a number of other techniques to facilitate the access to the data base. These include the links between the central processors and the communications control computers (front-enders) and between these front enders and the over 100 terminal devices operated by member districts.

Systems software development at TIES is based on the concept that application programs are users of the data base. The structure of the File Control Program is such that access to data by application programs is well defined and can be completed with relative ease. Thus new applications requested by member districts can be developed more readily.

For ease of management the applications software are divided into several functional modules.

Student and Census with responsibility for State Statistical Reports, Reference Lists, Projections, Scheduling, Mark Reporting, Attendance, Transportation, Class Lists, Special Studies and Auxiliary Reports.

Financial Systems with responsibilities for Paychecks and Registers, Distribution Reports, State and Federal Reports, Fixed Assets, Seniority Lists, Certification Reports, Leave Lists, Budget and Board Reports, Accounts Payable, Cost Accounting Reports, Revenue and Expenditure Reports.

Computer Managed Instruction and Computer Enhanced Instruction responsible for all classroom related activities; Comprehensive Achievement Monitoring, Computer Literacy, Basic, Fortran, Cobol, Simulations Drill & Practice, Tutorial, Guidance and Counseling.

Research Services included in which are Experimental Design, Survey Design and Analysis, Salary Simulations, Program Evaluation, Enrollment Projections, Follow-Up Studies.

All application programs, except for a few in the Computer Enhanced Instructional Area have been designed and developed at TIES. Input from User Advisory Committees has provided an invaluable base for this effort. The end result of the partnership of user and technician is a system which is responsive to the educational user and can provide accurate, timely and useful information in a variety of formats acceptable to a wide range of users.

THE HARDWARE SYSTEM

The hub of the TIES hardware system supporting the data base is two Burroughs B4700 Systems, each with internal memory capability of storing 500 thousand characters of information. These systems are multi-programmable and the memory size is large enough to allow fifteen to twenty five programs to be in the "mix" simultaneously.

The extensive data base at TIES is stored on five (5) banks of head-per-track disk. Each bank has the capacity to maintain 100 million characters of information. Supporting this on-line data base disk storage system are disk pack systems capable of storing additional 500 million characters. There are eight magnetic tape units capable of recording data at a rate of 320 thousand characters per second at a density of 1600 BPI. These units are used primarily to store information for back-up and emergency re-creation of the data base. This multiple back-up system ensures that in event of the complete loss of the data base, it can be reconstructed in its entirety within a few hours thus providing minimum interruption of services to member districts.

The numerous reports (payroll checks 100,000/month for example) are produced on three 1100 line a minute printers. Card input is minimized at TIES and is accomplished through the use of a 1400 card per minute reader.

To service and control the over 100 administrative terminal devices, the system incorporates four Burroughs B774 Front End Processors each capable of handling 32 half-duplex voice grade telephone lines.

Support of the over 200 instructional terminals located in classrooms, learning centers, counselor's offices and elsewhere in school buildings is provided by three Hewlett Packard 2000 series systems each with 32 ports.

THE FUTURE

Although TIES has been in operation for over eight years and much of the day-to-day needs of school districts have been met, the Design and Development staff is as large now as it was during the initial development effort. As well as enhancing current applications, this group keeps looking to the future and is developing applications to aid in the total operation of a school. Not least of these is related to an enlarged and much improved interactive system for the total management of a student's program in school to provide the teacher and the counselor a tool to maximize the learning through a well designed program of activities for each and every student based on individual needs. To improve the overall planning within a district the Design and Development application group are looking at simulations and models to develop a Total Management Information System that can be used on a day-to-day basis in a district. At the technical level improvement in operating software takes place almost daily, and in keeping with the TIES philosophy of providing the districts with as much control at the local level as possible, investigations are underway to determine the feasibility of providing clusters of micro-processor controlled remote devices in each district to allow distributive, decentralized processing.

Overall, the TIES organization will continue to direct its resources toward enhanced application of computer technology in the educational spectrum.

CAREER CHOICE
THE ALABAMA OCCUPATIONAL INFORMATION SYSTEM

David E. Sawyer
Executive Director

AOIS, Montgomery, Alabama 36104

ABSTRACT: The State of Alabama is currently implementing a computer based occupational information system that holds high promise for "putting it all together" in the matter of career choice. The system uses Time Share Corporation's Guidance Information System II as a base to develop a unique program for use by a variety of educational clients across the state. The system serves as an interpreter between data gathering agencies and individual users in secondary and postsecondary institutions. The system is operational with nine interactive files accessible by the student in his institution. An optical scanning interface is under development whereby students not convenient to the communication network may access the various files using marked sheets. The system will be available to 66% of the population within four years.

Are your local education agencies suffering from any of the following "lack of" syndromes?

- Lack of occupational data for students to effectively explore careers, make career decisions and/or plan for realistic career options:
- Lack of local accessing procedures for students to obtain specifically relevant and accurate data pertaining to his or her interests and/or aptitudes:
- Lack of a comprehensive system for efficient utilization of existing labor market and educational data collections, analyses: and reporting and disseminating practices;
- Lack of appropriate data in the classrooms to enhance career guidance activities and career exploration instruction;
- Lack of pertinent localized occupational data for vocational education program and facility planning;
- Lack of sufficient data to place the maximum number of terminating students in productive unsubsidized employment;
- Lack of accurate, reliable and locally relevant data for designing classroom and on-the-job training programs to meet the needs of local labor markets;
- Lack of a cross-indexing system of job related skills, aptitudes and abilities to job requirements and training programs;
- Lack of data to assist in placing students in training programs or in jobs requiring skills related to those possessed or for which training is available.

If you recognize any of these deficiencies, then a computerized occupational information system may be the solution.

The State of Alabama is currently implementing a computer based occupational information system that holds high promise for putting all of these "lack ofs" together to impact on the matter of realistic career choice in the educational environment. The development of this program is being supported under a grant from the Employment and Training Administration of the United States Department of Labor.

The information system is designed to accomplish the following objectives:

1. To help students learn about and understand the range of career opportunities presently available and that are likely to be available in the future.

2. To help entrants into the labor force become aware of occupations which they would find acceptable and personally satisfying.

3. To encourage persons in the process of career exploration and decision making to seek out career information on their own.

4. To increase awareness of major sources of occupational information for the purpose of acquiring knowledge of careers and preparation programs.

5. To provide support for related programs including career education, career and employment counseling, and manpower and educational planning.

The system operates as a separate function of State government responsible to a Board of Directors appointed by the Governor. The State

Superintendent of Education serves as Chairman of the Alabama Occupational Information System's Board of Directors.

The Alabama Occupational Information System (AOIS) is using TimeShare Corporation's Guidance Information System II as the base for its unique program designed to be used by a variety of persons across the State. The primary strategy is for the occupational-information system to serve as an interpreter between data gathering agencies and system users in secondary and post-secondary institutions, Employment Service Offices, rehabilitation centers and pre-release centers connected with our State prisons.

Current collections of labor market, education, financial aid, and career resource data are comprehensive and voluminous. Alabama's approach takes these data and reorients their format to best serve students who are seeking "facts" relative to career choice and career planning. Access is then made available through terminals connected to time sharing systems.

SYSTEM COMPONENTS

AOIS is operational with nine computer files. Each file, its capabilities and uses are described below:

National Occupational File (TimeShare Corporation). The National Occupational File contains more than 1300 primary occupations and 3000 related occupations which exist in the world of work. A wide range of approaches to exploring the occupational information file is available. A direct access or a structured search technique may be employed. Specific selectors are available to enable the student to delimit his interests rapidly and precisely. Categories for system output include 1) characteristics about industries; 2) characteristics about occupations within industries; 3) personal interest variables; 4) personal aptitude variables; 5) levels of formal education required; 6) special training requirements; 7) other preparation requirements; 8) areas of work within occupations; 9) employment outlook; 10) descriptive work activities by occupation; 11) working conditions; 12) physical demands; 13) other qualifications; 14) earnings range; and 15) special conditions. The system is organized around the 15 USOE occupational clusters. Each occupation is cross referenced to the DOT code. Alabama purchases this file from TimeShare Corporation under an annual license agreement. An example of an occupational description follows. The student may also request an itemization of all codes relevant to any occupation.

ARCHITECTURAL DRAFTSMAN
DOT# 001.281
LIVELIHOODS: CONST.

JOB DESCRIPTION AND WORKER REQUIREMENTS:
PLANS ARTISTIC ARCHITECTURAL &
STRUCTURAL FEATURES OF BLDGS &
STRUCTURES. SKETCHES DESIGNS & DETAILS
USING DRAWING INSTRUMENTS. MAKES
ENGINEERING COMPUTATIONS INVOLVED IN
STRENGTH OF MATERIAL, BEAMS, TRUSSES.
REQ. MATH ABIL., SPATIAL PERCEPTION,
DETAIL WORK & AT LEAST MODERATE HAND &
FINGER DEXTERITY.

RELATED JOBS:
005.081 STRUCTURAL ENGINEER
005.081 CONSTRUCTION ENGINEER
005.081 STRUCTURAL DESIGNER
005.081 AIRPORT ENGINEER

FOR FURTHER INFORMATION:
THE AMERICAN INSTITUTE OF ARCHITECTS
1735 NEW YORK AVE., NW, WASHINGTON,
D.C. 20006
SOCIETY OF AMERICAN REGISTERED
ARCHITECTS
600 S. MICHIGAN, CHICAGO, IL. 60605
VETERANS ADMINISTRATION
2625 SHIRLINGTON RD., ARLINGTON, VA.
22206

State Occupational Information File (AOIS). The State Occupational File follows the same structure as the National file but reflects State and regional data including local occupational outlook. Occupations included on the State file are selected from those identified by the Alabama Department of Industrial Relations in its publication Employment by Industry and Occupation. Preliminary work indicates the inclusion of over 350 occupations. These occupations reflect all levels of preparation and training and represent over 90% of the employment in Alabama. In addition, this file takes into account the needs of target populations such as handicapped students, prospective trainees, the unemployed, and others. An example of a state occupation including an exerpt of an itemization of relevant codes follows:

STATE OCCUPATIONAL INFORMATION READY

*FILE

ACCOUNTANT
DOT# 160.188

RELATED OCCUPATIONS:
160.188 BUDGET ACCOUNTANT
160.188 COST ACCOUNTANT
160.188 PROPERTY ACCOUNTANT
160.188 TAX ACCOUNTANT

JOB DESCRIPTION AND WORKER REQUIREMENTS:
ACCOUNTANTS PREPARE & ANALYZE
FINANCIAL REPORTS THAT FURNISH
MANAGERS WITH UP-TO-DATE FINANCIAL
INFORMATION TO MAKE IMPORTANT
DECISIONS.

THREE MAJOR ACCOUNTING FIELDS ARE
PUBLIC, MANAGEMENT, & GOVERNMENT
ACCOUNTING.

PUBLIC ACCOUNTANTS ARE INDEPENDENT
PRACTITIONERS OR EMPLOYEES OF
ACCOUNTING FIRMS. MANAGEMENT
ACCOUNTANTS, OFTEN CALLED INDUSTRIAL
OR PRIVATE ACCOUNTANTS, HANDLE THE

FINANCIAL RECORDS OF THEIR FIRMS. GOVERNMENT ACCOUNTANTS EXAMINE THE RECORDS OF GOVERNMENT AGENCIES & AUDIT PRIVATE BUSINESSES & INDIVIDUALS WHOSE DEALINGS ARE SUBJECT TO GOVERNMENT REGULATIONS.

PEOPLE PLANNING A CAREER IN ACCOUNTING SHOULD HAVE AN APTITUDE FOR MATHEMATICS. NEATNESS & ACCURACY ALSO ARE NECESSARY. EMPLOYERS SEEK APPLICANTS WHO HANDLE RESPONSIBILITY & WORK WITH LITTLE SUPERVISION.

FOR FURTHER REFERENCE:
ALABAMA ASSOCIATION OF PUBLIC ACCOUNTANTS
1025 SOUTH HULL STREET
MONTGOMERY, AL. 36104

1
ACCOUNTANT

2	BUSINESS AND OFFICE
20	PROFESSIONAL, TECHNICAL, AND MANAGERIAL OCCUPATIONS
33	ADMINISTRATIVE SPECIALIZATIONS
200	OCCUPATION DEALS WITH THINGS & OBJECTS
203	INVOLVES SCIENTIFIC TECHNICAL ACTIVITIES
207	INVOLVES NON-SOCIAL ACTIVITIES
220	ABILITY TO REASON AND MAKE JUDGEMENTS
221	UNDERSTAND AND USE WORDS EFFECTIVELY
222	DO ARITHMETIC QUICKLY AND ACCURATELY
225	UNDERSTAND VERBAL-TABULAR MATERIAL
242	INVOLVES DIRECTION, CONTROL, & PLANNING OF AN ACTIVITY
247	REQUIRES EVALUATION OF INFORMATION FROM FEELINGS OR OPINIONS
249	INVOLVES INTERPRETATION OF FEELINGS, IDEAS OR FACTS
250	REQUIRES ATTAINMENT OF PARTICULAR GOALS AND TOLERANCES
261	MOSTLY INSIDE
272	35-40 HOUR WEEK, WITH:
273	OVERTIME FREQUENT
280	OVERTIME OFTEN SEASONAL
281	OCCASIONAL TRAVEL
290	SEDENTARY - LIFT 10 LBS. MAX., LITTLE WALKING OR STANDING
297	INVOLVES REACHING HANDLING FEELING
299	INVOLVES ABILITY TO SEE CLEARLY
304	INVOLVES BOTH STANDING AND SITTING
320	BACHELOR'S DEGREE REQUIRED OR PREFERRED
321	MASTER'S DEGREE REQUIRED OR PREFERRED
322	POST GRADUATE PROFESSIONAL DEGREE REQUIRED OR PREFERRED
323	DOCTORAL DEGREE REQUIRED OR PREFERRED
335	ON-THE-JOB-TRAINING
337	BUSINESS SCHOOL AT LEAST 2 YEARS
341	ESSENTIAL EXPERIENCE IN SIMILAR JOBS
358	SPECIAL VOC TRAINING TIME REQUIRED - 4 YEARS AND OVER
365	NO SPECIAL TOOLS REQUIRED
397	STATEWIDE PRESENT EMPLOYMENT IS 2,000 - 3,999
432	EMPLOY. OUTLOOK GOOD, ROUGH BALANCE OF SUPPLY AND DEMAND
477	STATEWIDE ANNUAL AVG. JOB OPENINGS 400 TO 499
492	STATEWIDE USUAL ANNUAL STARTING SALARY IS 6,000 - 6,999
519	STATEWIDE USUAL ANNUAL HIGHEST SALARY IS 15,000 - 17,999
534	STATEWIDE USUAL STARTING HOURLY WAGE IS 3.00 - 3.49
562	STATEWIDE USUAL HIGHEST HOURLY WAGE IS 8.00 - 8.49
580	OTHER QUALIFICATIONS WHICH MAY BE REQUIRED: CERTIFICATION
581	OTHER QUALIFICATIONS WHICH MAY BE REQUIRED: EXAMINATION
582	OTHER QUALIFICATIONS WHICH MAY BE REQUIRED: LICENSE
611	BIRMINGHAM PRESENT EMPLOYMENT IS 2,000 - 2,999
831	BHAM EMPLOY. OUTLOOK VERY GOOD, DEMAND GREATER THAN SUPPLY
866	BHAM ANNUAL AVERAGE JOB OPENINGS 150 TO 174
889	BHAM USUAL ANNUAL STARTING SALARY IS 8,000 - 8,999
936	BIRMINGHAM USUAL STARTING HOURLY WAGE IS 4.00 - 4.49
975	BIRMINGHAM OTHER QUALIFICATIONS: CERTIFICATION
976	BIRMINGHAM OTHER QUALIFICATIONS: EXAMINATION
979	BIRMINGHAM OTHER QUALIFICATIONS: LICENSE
1010	MOBILE PRESENT EMPLOYMENT IS 1,000 - 1,999
1032	MOBILE EMPLOY. OUTLOOK GOOD, ROUGH BALANCE OF SUPPLY & DEMAND
1062	MOBILE ANNUAL AVG. JOB OPENINGS 50 TO 74
1089	MOBILE USUAL ANNUAL STARTING SALARY IS 8,000 - 8,999
1136	MOBILE USUAL STARTING HOURLY WAGE IS 4.00 - 4.49
1175	MOBILE OTHER QUALIFICATIONS: CERTIFICATION
1176	MOBILE OTHER QUALIFICATIONS: EXAMINATION
1179	MOBILE OTHER QUALIFICATIONS: LICENSE
1206	MONTGOMERY PRESENT EMPLOYMENT IS 600 - 699
1261	MONTGOMERY ANNUAL AVG. JOB OPENINGS 25 TO 49
1287	MONTG USUAL ANNUAL STARTING SALARY IS 6,000 - 6,999
1319	MONTGOMERY USUAL ANNUAL HIGHEST SALARY IS 15,000 - 17,999
1334	MONTGOMERY USUAL STARTING HOURLY WAGE IS 3.00 - 3.49
1362	MONTGOMERY USUAL HIGHEST HOURLY WAGE IS 8.00 - 8.49

[illegible] MONTGOMERY: OTHER QUALIFICATIONS: CERTIFICATION
[illegible] MONTGOMERY: OTHER QUALIFICATIONS: EXAMINATION
[illegible] MONTGOMERY: OTHER QUALIFICATIONS: LICENSE
[illegible] REFER TO AOIS CAREER RESOURCE LIBRARY FILE

State Occupational Training File (AOIS). The State Occupational Training File contains information on public, private and proprietary vocational and trade schools including area vocational centers and State technical colleges. In addition the file maintains information on training programs (new industry training, apprenticeship or other trade association or labor organization programs, adult vocational education programs, etc.) that are scheduled for 4 weeks duration or longer and have been submitted to our information developers no less than thirty days prior to start-up. This file includes entrance qualifications; physical qualifications; tuition and fees, if any; length of course; projected employment opportunities upon completion; average salary expectation upon completion, etc.

Two-Year College Information File (TimeShare Corporation). The Two-Year College Information File is designed to help explore opportunities available at the community and junior college level. The file includes an extensive list of objective characteristics relative to selecting an institution with a two-year curriculum. Information consisting of over 400 characteristics on over 1000 two-year degree granting colleges is available. The file is national in scope and can be delimited using various selectors including by state. Categories for student input include 1) conventional academic programs of study; 2) technological curriculums; 3) location; and 4) institutional characteristics including admission information, costs, competitiveness, etc.

Four-Year College Information File (Time Share Corporation). The Four-Year College Information File is designed to help explore opportunities and provide the student with quick and convenient access to comprehensive and up-to-date information on the nation's 1600 four-year colleges and universities. Over 600 characteristics can be used to select an institution. Input variables include 1) conventional academic programs of study; 2) location; and 3) institutional characteristics including costs, accreditation information, campus life information, athletic programs available, etc.

National Scholarship and Financial Aid File (TimeShare Corporation). The Scholarship and Financial Aid File is generalized detailing financial aid possibilities from sources such as the Federal government, foundations, business, military, trade associations and labor organizations, as well as religious and charitable groups. TimeShare's file represents over $750 million in financial aid possibilities.

State Scholarship and Financial Aid File (AOIS). The State Scholarship and Financial Aid File is similary structured to the national file except that it exhibits local potential including those unique to institutions in the State and those offered by private agencies and State and local associations and organizations.

Career Education Resource File (AOIS). The Career Education Resource File is designed for use by teachers who desire to incorporate occupational information into their respective instructional programs. Information found within this file also provides guidance personnel, administrators, and career counselors with resource information related to specific problems or community projects. A loan library is maintained by the State containing nearly 5000 items including books, films, filmstrips, monographs, and multimedia kits. The materials in the Career Resource File are annotated and are made available on a two-week basis to system users. An example of an item on this file follows:

```
NATIONAL APPRENTICESHIP & TRAINING
STANDARDS FOR CARPENTRY (C-AT-5-[illegible])

AUTHOR:
US DEPT OF LABOR, MANPOWER
ADMINISTRATION
NATIONAL JOINT CARPENTRY
APPRENTICESHIP & TRAINING COMMITTEE

RESOURCE DESCRIPTION:
THIS 38-PAGE BOOKLET, REVISED IN 1975,
CONTAINS THE LATEST TECHNIQUES &
STANDARDS OF WORK THAT COVER BASIC
REQUIREMENTS FOR EFFECTIVE
APPRENTICESHIP IN THE FIELD OF
CARPENTRY. IT IS OFFERED AS A GUIDE TO
LOCAL ORGANIZATIONS OF CONTRACTORS &
JOURNEYMEN IN ESTABLISHING LOCAL
SYSTEMS OF APPRENTICESHIP AND FOR
IMPROVING EXISTING SYSTEMS.

FOR FURTHER INFORMATION, PLEASE
CONTACT:

APPRENTICESHIP & TRAINING DEPT
UNITED BROTHERHOOD OF CARPENTERS
JOINERS OF AMERICA
101 CONSTITUTION AVENUE, N.W.
WASHINGTON, D.C. 20001

1
NATIONAL APPRENTICESHIP & TRAINING
STANDARDS
       CONSTRUCTION
[illegible]   STRUCTURAL WORK OCCUPATIONS
166    CONSTRUCTION (CARPENTRY,
         MASONRY, ROOFING, ETC)
204    HIGH SCHOOL (GRADES 10-12)
205    ADULT
308    BOOKLET
400    AOIS
700    CHECK THE STATE TRAINING FILE
800    CHECK THE OCCUPATIONAL FILES
900    CHECK THE FINANCIAL AID FILE
```

Employment Service Job Bank Summary File (AOIS). This file is designed to key system users with skills to currently listed job openings by local ES offices. Accessing this file by either local office identifier or the six digit D.O.T. code for a given occupation provides the user with information on the average number of vacancies based on the preceding week in any requested geographic area. Placement assistance and referral service is provided by the local ES office as referenced on the file.

SELECTION STRATEGIES

AOIS includes procedures to allow students to retrieve information based on their individual interests, skills and/or aptitudes through on line selectors. Specifically the following selectors are provided for each file:

The National Occupational File:

A. USOE occupational cluster (15 selectors)
B. Occupational characteristic (9 selectors)
C. Personal interest characteristics (10 selectors)
D. Level of formal education (14 selectors)
E. Special training (15 selectors)
F. Training other than formal education (9 selectors)
G. Personal aptitude characteristics (10 selectors)

The State Occupational File:

A. USOE occupational cluster (15 selectors)
B. Occupational characteristic (9 selectors)
C. Personal interest characteristics (10 selectors).
D. Level of formal education (14 selectors)
E. Special training (15 selectors)
F. Training other than formal education (9 selectors)
G. State geographic area (3 selectors)
H. Personal aptitude characteristics (10 selectors)
I. Handicapping condition (14 selectors)

The State Occupational Training File:

A. USOE vocational program code (415 selectors)
B. Institution type (5 selectors)
C. Geographic area (8 selectors)
D. Institution/Agency (# of selectors varies.

Two-Year College File:

A. Major (23 selectors)
B. Technological and occupational curricula (80 selectors)
C. Location (64 selectors)
D. Size of city or town (5 selectors)
E. Enrollment (5 selectors)
F. Coeducation characteristics (5 selectors)
G. Control (2 selectors)
H. Religious affiliation (5 selectors)
I. Admission information (13 selectors)
J. Annual tuition and fees for in-district, out-of-district, or out-of-state students (12 selectors)
K. Annual tuition, fees and room & board for in-district, out-of district or out-of-state students (12 selectors)
L. Financial aid (13 selectors)
M. Type of institution (8 selectors)
N. Regional accreditation (3 selectors)
O. Special programs and services (8 selectors)
P. Calendar plan (5 selectors)
Q. Campus life (18 selectors)
R. Academic characteristics of the student body (22 selectors)
S. Faculty characteristics (2 selectors)
T. Athletic programs available (30 selectors)
U. Campus activities (12 selectors)
V. Major (23 selectors)
W. Technological and occupational curricula (80 selectors)
X. Admission information (13 selectors)
Y. Academic characteristics of the student body (22 selectors)

Four-Year College File:

A. Major (330 selectors)
B. Location (64 selectors)
C. Size of city or town (5 selectors)
D. Total enrollment (5 selectors)
E. Coeducation characteristics (5 selectors)
F. Graduate student enrollment (2 selectors)
G. Control (2 selectors)
H. Religious affiliation (5 selectors)
I. Tests required prior to admission (5 selectors)
J. Time of admission (6 selectors)
K. Personal and geographic factors of admission (3 selectors)
L. Admission decisions policy (2 selectors)
M. Institution admissions competitiveness (6 selectors)
N. Application deadline (5 selectors)
O. Annual tuition and fees (10 selectors)
P. Annual tuition, fees and room and board (12 selectors)
Q. Financial aid (9 selectors)
R. Student financial aid award descriptions (4 selectors)
S. Type of institution (9 selectors)
T. Regional accreditation (3 selectors)
U. Special programs available (12 selectors)
V. Calendar plan (6 selectors)
W. ROTC available (4 selectors)
X. Campus life variables (18 selectors)
Y. Academic characteristics of undergraduates (20 selectors)
Z. Athletic programs available (31 selectors)
AA. Faculty characteristics (2 selectors)
AB. Campus activities (12 selectors)
AC. Courses in emerging fields of interest (7 selectors)

The National Scholarship and Financial Aid File:

A. Religious affiliation (12 selectors)
B. Descent: Racial or ethnic (15 selectors)
C. Student organizations (19 selectors)
D. Career plans (49 selectors)
E. Cooperative work-study program (33 selectors)

F. Parents' associations (10 selectors)
G. Parents' unions (16 selectors)
H. Parents' present employment (13 selectors)
I. Parents' past military service (6 selectors)
J. Parents' current status (26 selectors)
K. Miscellaneous work experience (16 selectors)
L. Contests, competitions, and examinations (32 selectors)
M. Miscellaneous work experience (16 selectors)

The State Scholarship and Financial Aid File:
A. Religious affiliation (12 selectors)
B. Descent: Racial or ethnic (15 selectors)
C. Student organizations (19 selectors)
D. Career plans (49 selectors)
E. Cooperative work-study program (33 selectors)
F. Parents' associations (10 selectors)
G. Parents' unions (16 selectors)
H. Parents' present employment (13 selectors)
I. Parents' past military service (6 selectors)
J. Parents' current status (26 selectors)
K. Miscellaneous work experience (16 selectors)
L. Contests, competitions; and examinations (32 selectors)
M. Institution (varies)

The Career Education Resource File:
A. Area of interest (15 selectors)
B. Occupation (96 selectors)
C. Career guidance (6 selectors)
D. Grade level (6 selectors)
E. Media (8 selectors)
F. Location and cost (3 selectors)

The Employment Service Job Bank Summary File:
A. Six-digit D.O.T. (varies)
B. Geographically (26 offices)

INFORMATION DELIVERY

Information delivery is via terminal physically located in the user agency facility; be it a school, an ES office, a prisoner pre-release center or a rehabilitation center. The delivery is accomplished using a series of mini-computers each capable of providing service to multiple simultaneous users via timesharing. Such a procedure allows for immediacy of information retrieval and an opportunity for interaction with the available files. Unlimited connect time is afforded each user agency at a nominal cost.

The terminal is student operable and requires no special training or typing skills. Users have manuals available that provide the proper orientation prior to their first experience at the terminal. The printout provided by the computer belongs to the student for future reference or for discussion with counselors and parents.

An optical scanning interface is being developed whereby agencies not convenient to the communication network may access the various files by using a marked sheet. Such a procedure cancels the immediacy of retrieval and interactive benefits but will allow for information dissemination to the rural and more remote areas of the State.

Putting it all together in the matter of Career Choice? Alabama, via computers in education, is making a concerted effort at accomplishing this goal.

WISCONSIN'S COMPUTER BASED CAREER INFORMATION SYSTEM

Dr. Roger H. Lambert, Associate Director

Center for Studies in Vocational and Technical Education

University of Wisconsin-Madison

and

Director, Wisconsin Occupational Information System

ABSTRACT

The Center for Studies in Vocational and Technical Education, University of Wisconsin-Madison, has been chosen by the U.S. Department of Labor National Occupational Information Service to implement an occupational information system in Wisconsin under a grant to the Wisconsin Manpower Services Council. The grant was one of an initial eight for state-wide occupational information system development. It is expected to continue over a period of four years with the amount of federal aid decreasing after the second year until agencies and users bear the total cost of the system. The Wisconsin Occupational Information System (WOIS) combines computerized and manual information files, audio-visuals, and printed materials relating to national and state occupations, training institutions and institutions of higher education, financial aids, human resources and careers in the military. The central staff of WOIS collects information from such "providers" as the Job Service, Department of Labor, and educational agencies and organizes it for easy individual access by such "users" as high school students, the unemployed, and other job seekers.

WISCONSIN'S COMPUTER BASED CAREER INFORMATION SYSTEM

The Wisconsin Occupational Information System (WOIS) is a computer based program to provide quick, accurate and up-to-date occupational information for career decision making to a variety of publics. Student entrants into the labor force, the unemployed, minority groups, educational and manpower planners, inmates of correctional institutions and clients of vocational rehabilitation facilities are all potential users. The goals of the program are:

1. To help persons learn about and understand the range of careers now available and likely to be available in the future.

2. To help labor force entrants become aware of occupations which are acceptable and personally satisfying.

3. To encourage persons in the process of making career decisions to explore vocational possibilities on their own.

4. To increase awareness of major sources of occupational information.

5. To provide support for related programs including career education, career and employment counseling and manpower and educational training.

System Components

WOIS contains four major components for delivery of information to users. The heart of the system consists of separate computerized files for 1) national occupations 2) state occupations 3) 4 year colleges nationwide 4) education and training of less than a baccalaureate degree 5) financial aids 6) human resources and 7) an index to military jobs.

Access to the information files may be direct or structured and is accomplished via a computer terminal located at the school or other user site. Structured access enables individuals to insert self descriptions which are then used by the computer to select occupations or other information depending upon the type of file. Direct access enables the individual to identify immediately specific information about jobs, colleges or other items from any file by directly inserting a code number which corresponds to the particular occupation, college, financial aid, or training program.

The second major component is the manual delivery program, which utilizes the Wisconsin Information for Students and Counselors (WISC) Deck, called the VIEW deck in many states, to provide information on microfiche. The WISC Deck and the computerized files are cross-referenced, as the WISC deck contains expanded information on the various occupations and training programs. The primary difference between the computerized files and the WISC deck are 1) the WISC deck uses longer descriptions of the occupations and training programs, 2) it is updated every two years, whereas the computer file is updated every six months, and 3) it does not have a structured access program, only direct access.

The third major delivery component is printed material. This material, primarily in the form of career briefs, is available as general background on various occupations by industrial clusters, is updated approximately every four to five years, and contains approximately ten to forty occupations per brief.

The fourth component of the Wisconsin Occupational Information System consists of various types of audio-visual materials such as the Employability Skills Program and other career education filmstrips, films, and audio tapes. These materials supplement the information in the automated, microfiche and printed material files. A Graphic Display of the components of WOIS follows.

Involvement of Students, Parents and Professionals

The major components of WOIS are designed to be usable by the student. The computerized files, the WISC Deck, the Occupational Briefs, the Employability Skills materials and other audio-visual or printed materials are all easily manipulated with relatively little instruction needed prior to operation. The students are provided with instructional guide, worksheets and computer command displays developed by self-instruction.

When the student types in the appropriate command, this signals the computer to respond on the basis of instruction. If the student is just starting the system, the computer will ask him/her to identify the program or file. The student then types in a code, such as OCCU for occupational information at the national level, or SOCCU for information at the state level. He/she may also choose any of the other files in the system; steps for accessing the files are contained in the user guide. Disposable worksheets are provided so that the student guide may be reused many times. Five basic commands are used to interact with file information. The "A" command means add, "S" means subtract, "E" means either/or, "D" means delete and "P" means print. In addition to the specific letter command the student inserts the numeric number of characteristics to be included in the search strategy.

Each file operates in the same manner. The student selects from descriptor groups, adds, subtracts or deletes items as he progresses through the exploration of the file content. At various points he/she may ask the computer to print out certain kinds of information such as a list of schools, occupations, human resources or financial aids. He/she may also ask the computer to print specific information on any one or several of the titles previously listed. For example, the search may have been narrowed to three specific occupations. First the titles of the occupations can be printed and then the complete descriptions of one or all three. The printouts provide a permanent record for the student and may be used for discussions with counselors, peers or parents. When sufficient information has been secured, an appropriate command is entered which signs off the file and readies the system for selection of another file or the exit program.

The exiting strategy questions the student about whether the necessary information was provided. For example, if satisfactory information is secured, the computer responds with the next step in career planning. This may be a visit to a counselor or consideration of another resource such as Employability Skills or other printed materials. If the student does not secure the information, the computer will respond with directions to re-enter the system or obtain additional information from other resources such as the WISC Deck or printed information. The specific directions will depend on the student's assessment of the interactions with the system.

The WOIS instructor guide details the file information and the strategies used in accessing the computerized files. The interrelationships of the computerized files, the manual WISC Deck, the Occupational Briefs and the audio-visual materials are also explained. The instructor guide provides information on access to or utilization of the file which is not included in the student use guide.

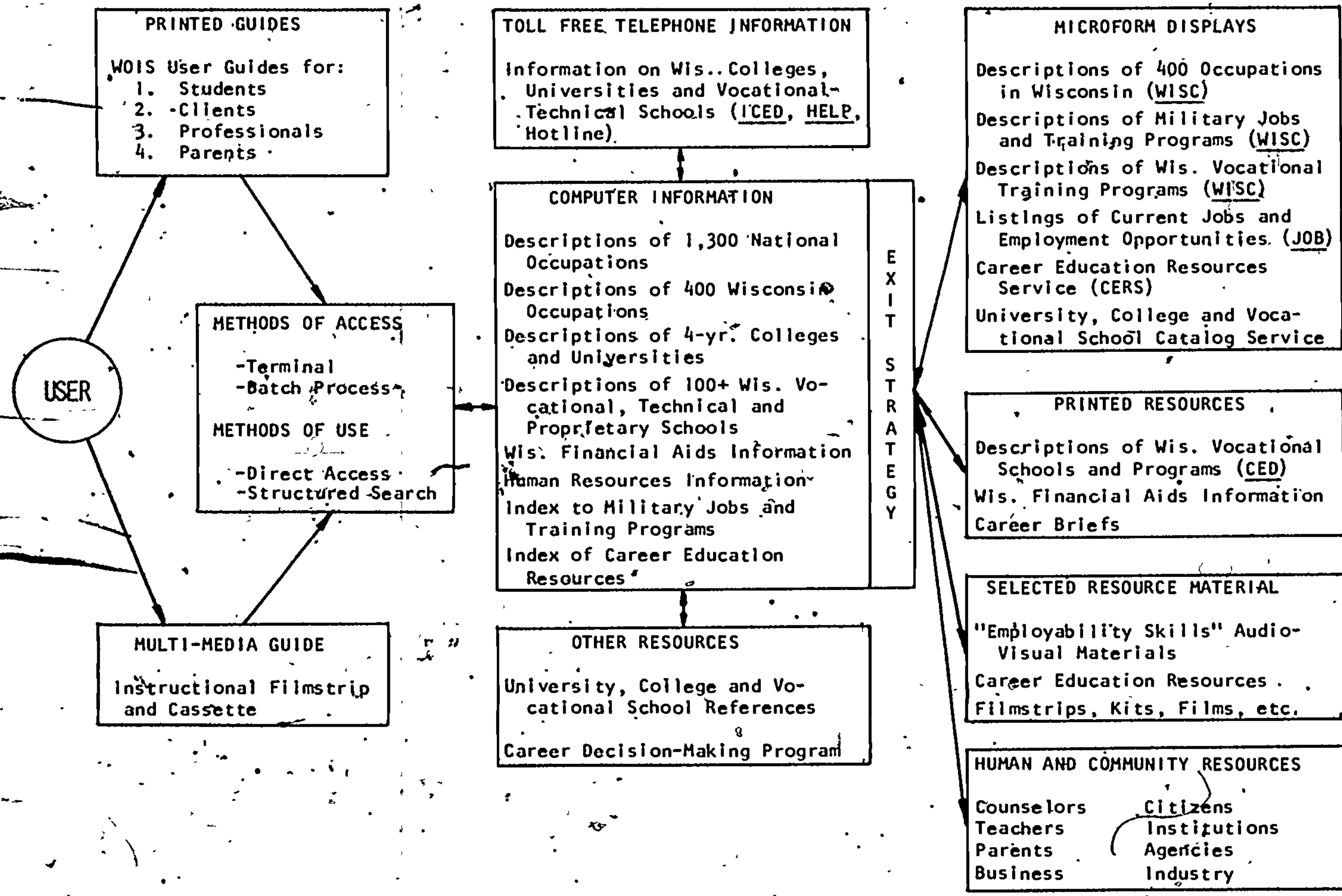
A guide for parents is also included. This explains the system, kinds of information, and the process used to obtain the information. It also includes suggestions on how parents might discuss this information with their child, an explanation of the computer printout, and a listing of other information which may be available to the students.

File Contents

The Occupational Information files are the most significant part of the system. Detailed descriptions of over 400 occupations at the state level and over 1,300 occupations at the national level are included. The WOIS staff are working closely with the Bureau of Research and Statistics, Department of Industry, Labor and Human Relations, the Job Service offices throughout the state, and other information sources to supply accurate information. Each occupation is assigned a 6 digit code number from the Dictionary of Occupational Titles. This serves as a source for exploring other occupations with related work characteristics. Each occupation is cross referenced to the other files, to th WISC Deck, to educational requirements and to military occupations.

The purpose of each job is defined and explained in terms of specific duties and tasks. The working conditions or work environment are also detailed. Information is included on where the work is done, i.e. inside, outside, assembly line or small office. Work hours, limitations, temperature and climate conditions, the degree of physical involvement (including any special or dexterity problems), the amount of personal contact with others, and environmental problems are incorporated. Information on earnings, including hourly rates, beginning, average and maximum salaries appears in the description. Pay provisions, fringe benefits, vacation and other economic considerations including costs to the worker for union membership, tools, uniforms, and equipment are also found in this material. There is a complete description of job supply and demand

WOIS DELIVERY DISPLAY



with employment forecasts on state and regional bases.

Each job description has a formal career ladder and explains promotional opportunities and pre-entry requirements including training levels and locations. Jobs with similar work traits are referenced, as are several sources of additional occupational information within WOIS. Military occupations are cross indexed to enable the user to relate civilian job titles to those used in the military. References direct the user to the military occupations source books for further information.

The education and training files contain information on four year colleges nationwide and more than one hundred Wisconsin institutions which provide less than a baccaulearate degree. The Wisconsin file will cover all of the public vocational technical schools, the two year University centers, proprietary schools, and others. Information on programs of study, fees, tuition, size, location, extra curricular activities and many other points of information are covered.

The financial aids file contains information on Federal, state and local student financial aids and scholarships. It describes the type of aid, the eligibility requirements, the amount, the number awarded, the application procedures, deadline dates, sources of further information and other pertinent details.

The human resource file is designed to provide the user with names and addresses of individuals, agencies and organizations which may be contacted for further information concerning occupations, careers, career planning or other student needs.

The Software for Delivery System

The software for the delivery of the computerized information is the Guidance Information System (GIS), a product of Time Share Corporation and the Houghton-Mifflin Company. The present Guidance Information System evolved from concepts and experiences resulting from a project sponsored by the U. S. Office of Education at Harvard University. This project, the Information System for Vocational Decisions, was a three year effort initiated in June, 1966 by Dr. David V. Tiedeman, Professor of Education at Harvard.

The Guidance Information System makes it possible for students to explore large data files stored in a computer and to examine the ways in which their personal criteria for selecting occupations, education and the other information affects the range of opportunities available to them. When the student sends instructions to the computer, he/she receives an immediate response which allows him/her to compare the results of choices and decisions with the results of other choices.

The unique aspect of the Guidance Information System is that it allows for direct interaction with the information. The individual may change instructions at any point, thereby taking responsibility for decision-making. The intention is not to provide matching or placement services, but to close the communications gap between the facts and those who need to use those facts for effective career choices.

The design of the software system is such that each file is entered individually. This characteristic has both advantages and disadvantages. The disadvantage is that a student must select one file to work with at a time and therefore cannot secure information from another without changing files. the advantages of this type of system include: 1) core requirements are small, making it inexpensive to run and 2) the addition of files to the system, such as a human resource file and financial aids file or others, does not overload a small computer.

Hardware for the Delivery System

Hardware used in the delivery of the WOIS includes computers, telephones, computer terminals, microfiche readers and/or reader/printers, filmstrips, slide and movie viewers and cassette players. Several types of computers are currently being used, including the Hewlett Packard 2000 and 3000 series, the UNIVAC 1110 and the DEC PDP 11/45. In the near future it is expected that the program will run on IBM and Burroughs equipment as well as models of previously named systems.

Teletypes connecting the computer system vary in cost and design. The most common are basic teletype units capable of printing ten characters per second, although other units capable of up to 30 characters per second are also used. The slower units use mechancial printing capability while the faster ones generally have thermal printing features. Cathode-ray tube (CRT) terminals with thermal printers are also possible. The printing capacity is necessary to provide users with a permanent record of the information requested. The terminals are connected to the computer by either didicated telephone lines or dial access systems. The dial access utilizes a regular telephone with an acoustic coupler at the terminal. When the telephone receiver is placed on the acoustic coupler, it connects with the computer. The didicated line is a direct connection from the terminal to the computer and is generally the most economical. Microfiche readers and other audi-visual tools found in most audi-visual departments are also used with the program.

WOIS User Costs

The cost of providing WOIS to the user is between three and four thousand dollars per year, per terminal location. This cost includes the computer time, terminals, line charges, in-service training, the WISC deck, the student user guides, instructional manuals, and the student worksheets. Additional cost on a one time basis may be incurred to acquire audio-visuals and other printed materials. The cost to an individual school depends on three things: 1) the type of terminal rented or purchased 2) the distance and type of communication line to the computer source and 3) the number of students having access to the individual terminal. Every attempt has been made to keep the cost to a minimum. Considering the quantity of information, its comprehensive and current nature, the cost for full time use of WOIS is surprisingly low. Approximately 1,200 students can be accomodated by one terminal during an academic school year. In many schools, the cost of the hardware and communications can be spread over additional uses, such as computer assisted instruction and administrative systems available at the distribution centers.

Organization of WOIS

The Wisconsin Occupational Information System is governed by a Board of Directors which is a policy making consortium representing secondary and higher education, manpower and social service agencies, management, labor and other interested groups. The Board constitutes a Special Task Force of the Wisconsin Manpower Council and is authorized to receive and expend Federal monies. It meets on a bimonthly basis and is actively involved in the development and implementation of the program.

A central staff takes responsibility for overall system development and updates occupational information for the delivery centers. It collects information from "providers" such as the Job Service, Department of Labor, educational agencies, state planning agencies and business and industry and organizes it so that "users" will have easy and consistent access to it through various mediums of delivery. These mediums include among others, written materials, audio-visuals, computer terminals, and microfiche.

Statewide delivery of WOIS is organized through regional distribution centers, existing or planned facilities capable of delivering computer assisted instruction to local high schools, colleges and other agencies. Regional delivery makes use of existing computer center and terminal configurations, minimizes telecommunications costs and allows the system to run on different types of hardware. A central computing facility will provide regional centers with an updated tape twice each year.

Development of WOIS

Currently in its first year of operation, the program is a result of a grant from the U.S. Department of Labor/National Occupational Informational Service. Seven additional states from an initial 45 applicants were also funded. The Center for Studies in Vocational and Technical Education, University of Wisconsin-Madison, was chosen to implement the program with the Wisconsin Manpower Services Council acting as the state agency responsible for receipt of funds. The grant is expected to continue over a period of four years with the amount of federal aid decreasing after the second year, until the total operational cost is borne by the agencies and users involved.

The need for a statewide occupational information system in Wisconsin was made clear when several agencies within the state made independent attempts to provide information to those in search of jobs or job training. None of these programs were of sufficient scope to be classed as a statewide comprehensive occupational information system. The necessary stimulus for the statewide network was the WOIS grant program.

Summary

The Wisconsin Occupational Information System provides young persons and adults in Wisconsin with a unique and comprehensive source of information for career palnning and decision making. Using the automation of computers coordinated with manual information files, the system relieves the professional staff of the time consuming chores of gathering, filing and relocating information for student or client use.

Major components of the automated system include information at the local, state and national level pertaining to occupations, vocational training, four year colleges, military jobs, financial aids and human resources for personalized job information.

The involvement of numerous state agencies in a consortium effort to provide this comprehensive system of career information and related guidance materials enables local schools, colleges, technical institutes, job service offices, vocational rehabilitation offices and others to utilize the system benefits at a fraction of the cost of individual development and maintenance.

GIS II: AN INNOVATIVE APPROACH TO THE DISSEMINATION OF CAREER GUIDANCE INFORMATION

Linda L. Kobylarz
Education Consultant

Time Share Corporation

ABSTRACT: The concept of "Career Education" has been nationally advocated as a means to more fully meet the needs of students facing both the choices and demands presented by a rapidly changing technological world. To facilitate effective student decision-making, the original Guidance Information System (a computer-based data retrieval system housing information on occupations, colleges, and financial aid) has been further developed to equip students with instantaneous cross-referencing capability to access additional information on careers from a variety of multi-media sources, as well as from local data sources. GIS II can be easily infused into existing Career Guidance programs and can serve as the hub of an action oriented Career Resource Center. GIS II is equally useful to college and adult populations seeking career guidance information.

During the past few decades, our nation has been faced with extensive sociological, psychological, and economic changes. Concurrent with these changes has been a tremendous increase in the number of options available to individuals. To help young people meet the challenges these and other factors pose, educators are faced with the task of improving existing programs and developing new ones that are designed to better equip youth with the wide array of skills necessary to realize their fullest potential.

BACKGROUND

The concept of Career Education has been nationally advocated as a means to more adequately prepare young people to cope with both the demands and choices before them. In the broadest sense, Career Education is a developmental process through which an individual can be helpedto gain knowledge of himself and the world of work and to learn the skills needed for effective planning and active participation in the greater society. Three of the key components of most Career Education programs focus on: increasing a person's self-awareness, increasing his/her understanding of lifestyles and career roles, and increasing his/her skill level in decision-making and planning. Basic to each of these elements is the availability of sound information. Whether the information is about an individual's interests and abilities or about the potential job market for lawyers in 1985, it must be readily accessible, accurate, and up-to-date.

Much of the responsibility for providing Career Education related information falls within the realm of school guidance personnel. Throughout the country, there are many attempts underway to implement new approaches to career guidance. That these new approaches are sorely needed has been highlighted by a recent study (Prediger, et al, 1973, p.9) of the career development needs of high school students. The students, chosen from a nation-wide sample, indicated that help with making career plans was their most important area of need. This was in sharp contrast to the amount of help in career planning students said they recieved from their counselors. The students in the Prediger study also evidenced an alarming lack of knowledge about the world of work per se (Prediger, et al, 1973, pp.29-33).

The inportance of information to the career decision-making process is often cited in the relevant liturature. In his well known work on career development theory, Donald Super notes that information concerning occupations is a vital element of the crystallization and specification stages of vocational development (Osipow, 1968, p.124). In the "Conceptual Framework of Occupational Choice" described by Blau, et al (Bailey and Stadt, 1973) occupational information is characterized as one of the immediate determinants of occupational choice. Hoppock sums up the role of occupational information this way: "(it)...affects occupational choice by helping us to discover the occupations that may meet our needs and by helping us to anticipate how well satisfied we may hope to be in one occupation as compared with another." (Hoppock, 1967, p.112)

AN INNOVATIVE APPROACH

Recognizing the critical need to provide career information to students, forward looking guidance departments are reassessing not only the quantity and quality of the information now available to their students; but also, the manner in which the information is presented. The utility of traditional methods of career information dissemination are being questioned and new techniques of accomplishing the objective are being sought. The Guidance Information System II (GIS II) draws upon the latest technological innovations to help counselors deal with the problem of providing a career information delivery system that is current, accurate, and easily accessible. GIS II is a computer-based system which provides instantaneous remote access to occupational, college, and scholarship data which is regularly up-dated and checked for accuracy.

GIS II traces its roots to a project conducted at Harvard University under the direction of Dr. David V. Tiedemann. GIS II is the result of a five year developmental process of modifications, improvements, and expansions carried out by Time Share Corporation in cooperation with Houghton Mifflin Company. This well-proven and highly successful system is now utilized in more than 1000 high schools, colleges, and career centers through out the country.

The actual operation of GIS II, from the user's point of view, is really quite simple. A student or counselor "communicates" with the computer storing GIS II information through a terminal located in his/her own school. The user types simple instructions through the terminal which allow him/her to interact in a rather unique way with information on over 1200 occupations and more than 2500 colleges. Individuals working with GIS II use the Student Guide, which details many characteristics about occupations or colleges, to select those items they might want to include in their search. For instance, in the Occupational File, jobs are grouped by both the 15 clusters identified by the U.S. Office of Education and the DOT Worker Trait methods. Individuals can also choose from characteristics of occupations such as aptitudes and interests usually related to a particular job, and education or training required. The Student Guide also provides a way for users to get additional information from the computer on salary ranges, employment outlook, physical demands, etc. for each occupation in the file. The Student Guide is structured so that it provides initial broad organization to a college or occupation search, while at the same time allowing for great flexibility within that organization.

GIS II makes it possible for a student to examine the ways in which his/her personal criteria for making decisions about occupations or colleges affects the range of options available. Because the instructions being given to the computer can be modified at any point, GIS II also permits each user to see not only the results of one set of decisions; but, to change his/her mind and to explore the ramifications different choices would have. This flexibility greatly enhances the usefulness of GIS II and makes it a viable tool in the development of decision-making and planning skills. In essence, GIS II closes the communication gap between the facts and those who need to use them for effective decision-making.

Not only does GIS II supply large amounts of computer-based data, it also provides a special cross-referencing systemwhich allows its users to access additional sources of career information. The referenced materials include sound film strips, kits, printed job briefs, posters, and microfiche usually found in career resource centers. GIS II can thus form the hub for extensive career exploration and decision-making experiences and bring students into contact with a variety of information presentation formats. The value of this feature is easily appreciated when one considers that students vary greatly in the ways in which each best assimilates information; ie. some students react best to oral presentations, some to visual, etc. The cross-referencing aspect of GIS II can also be used by career resource center managers to enhance the visibility of other materials in the center.

SUPPORTIVE RESEARCH

Questions have been raised regarding the effectiveness of the new technologies in presenting career information. Several recent studies indicate that computerized occupational information systems positively affected the career decision-making skills of students. Pierce (1972) reports a high degree of success with students utilizing computers in pursuing occupational information. Chick comments that the interactive nature of the process used to obtain data from a computer seems to elicit from students a greater sense of involvement and responsibility in their decisions. She further notes that evaluation of some computer-based systems reflects that students often felt that it was easier to relate to the computer (bias-free and non-judgemental) than to another person. (Chick, 1972, p.34) The author assisted Dr. Thomas English (1973) in his investigation of the impact of GIS and VIEW (Vocational Information for Education and Work--localized career information in microfiche format) on the vocational maturity of students attending an inner city high school. Compared to a control group, users of both VIEW and GIS gained significantly in the areas of "Planning Orientation" and "Information and Decision-Making" as measured by the "Career Development Inventory" (Super, et al, 1971).

Although the research confirms the value of computerized techniques in accessing career information, a word of caution might be appropriate at this point. A study of career centers in California (Jacobson, et al, 1975, pp. 44-45) revealed that although students preferred audio-visual materials to printed materials, the actual use of audio-visual materials was far less than expected. Students working independently in career centers hesitate to use the complicated looking AV equipment with which they are often unfamiliar. In the California Study it was recommended that all students be given hands-on experiences with the equipment in the career centers. Computer systems might face a similar problem. With this is mind, Time Share has developed a complete training program which provides in-service training for counselors working with GIS II and a sound filmstrip which introduces GIS II to students and fully demonstrates how to use the total system. A film designed to acquaint parents, school administrators, teachers, and community groups with GIS is also available. It has been this writer's experience that after only a short orientation to GIS II, students begin to use the system independently and with ease.

In planning a comprehensive career guidance program, counselors would do well to note, as indicated above, that ample evidence exists to support the adoption of a computerized information system such as GIS II and microfiche information systems such as VIEW, which, incidentally, can be cross-referenced by GIS II.

CONCLUSIONS

GIS II can be described as a composite type of resource which, through its cross-referencing capabilities, brings together much of the data needed in the initial stages of the career decision-making process. It is a dynamic and highly motivational tool which can serve as a valuable support system in a total career guidance effort. It implements the counselor's role by relieving him/her of the mechanical tasks of information collection, revision, and dissemination so that the counselor is free to spend more time with students to help them personalize and integrate the information they have received into plans that are consistent with their aspirations and goals.

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SIGI -- A COMPUTER-BASED AID TO CAREER DECISION-MAKING

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Abstract: SIGI, a computer-based guidance system for college students has been developed by ETS. This presentation will summarize the program's conceptualization and operational experience to date.

A computer-based guidance system designed to help college students make career plans and decisions has been developed by the Educational Testing Service of Princeton, New Jersey. Called the System of Interactive Guidance and Information, or SIGI, the new approach is based on a guidance theory that emphasizes each student's own values. A student taking part in the guidance program interacts with one of several terminals connected to a PDP-11 RSTS/E computer system manufactured by Digital Equipment Corporation. Development of SIGI at ETS started in 1968, with supporting grants from the Carnegie Corporation and the National Science Foundation.

SIGI is based on a humanistic philosophy, a theory of guidance that emphasizes the primacy of individual values, a vast store of occupational data, and a strategy for processing information--all blended into a unified system.

The system is designed so that different students may use it in distinctive ways. Every student represents a unique combination of needs, values, interests, abilities, perceptions, preferences, and plans. Different students may be at different stages in career decision-making. Each student, therefore, requires unique treatment. Yet there are regularities within the process of decision-making that can be used to establish a structure within which these unique characteristics operate. Thus, SIGI provides a clearly defined structure, but responds flexibly to individual needs and circumstances.

What does SIGI try to accomplish?

The main purposes of SIGI are to increase students' freedom of choice, to develop their understanding of the elements involved in choice, and to improve their competence in the process of making informed and rational career decisions. In this process, they examine their own values searchingly, explore options systematically, interpret relevant data accurately, and formulate tentative plans as hypotheses that can be tested realistically. They also learn to modify their plans as they gain new insights, experience, and information.

The choices directly considered include educational and occupational options. Emphasis, however, is not only on the content of decisions, but on the process of decision-making.

How does SIGI work?

The student interacts with the system via a cathode-ray tube (CRT) terminal, one of several connected to a PDP-11 computer. The terminal consists of a screen and an array of response keys. Messages, called frames, are presented (or constructed) on the screen, and the student responds to a question, asks a question, or gives directions to the computer by pressing designated keys. Sometimes the screen gives information to the student. Sometimes it gives the student choices of what to do next. Sometimes it serves as a spokesman for the student, who may try out and modify various expressions of his or her own values, specifications of minimum requirements, and occupational goals and plans.

The student's dialogue with the computer about career decisions takes place in a multiple-choice format. This format candidly and explicitly specifies the structure of the system to students, yet permits them to branch through a multiplicity of pathways within that structure. It instructs them in the rules and possibilities of the decision-making process, but allows them to make the decisions for themselves.

Each student proceeds at his or her own pace. Scripts are written for the eighth-grade level of reading, but slow readers have been able to use SIGI--it simply takes them longer. Most students spend two to four sessions at the terminal, although some will use considerably more.

The computer records everything that each student tells it and keeps track of every branch that each student follows. As students progress through SIGI, they develop competencies and master strategies for rational decision-making. They learn to move freely within the structure of SIGI, and eventually gain control of the system to use as they see fit.

What is the content of SIGI?

Stored in the computer are sequences of frames, or scripts, that flesh out the model of guidance for career decision-making. The full model incorporates six major subsystems: VALUES, LOCATE, COMPARE, PREDICTION, PLANNING, AND STRATEGY.

The student first goes through an overview of the entire system. This overview enables the student to sample all six subsystems. The student then becomes an "initiate" and is free to use any subsystem at any time. Throughout, the student encounters recurrent attention to values. Values serve as a major synthesizing element in an individuals' self concept and a dynamic force in decision-making: they provide the dimensions along which students construe their own desires and analyze occupatoinal characteristics.

VALUES. Students explore the role of values in decision-making and examine their own values. They learn that making a decision often requires choices between competing values. A series of 10 occupational values are defined in operational terms, and the students weight each value in accordance with its importance to them.

FIGURE 1

WEIGHT (IMPORTANCE)

None (0), (1), Slight (2), (3), Medium (4), (5), Strong (6), (7), Highest (8)

SECURITY. In the most SECURE occupations, you will be free from fear of losing your job and income. You will have tenure—that is, you cannot be fired very easily. Employment will tend to remain high in spite of recessions, and there will be no seasonal ups and downs. Your income will generally remain stable and predictable, it will not vanish with hard times. Your occupation is not likely to be wiped out by automation or other technological changes.

Press one of the numbers (0-8) to show how important it is to you to work in an occupation that offers steady employment and income.

After this independent weighting of one value at a time, the weights for all 10 values are gathered in graphic form, and the student has a chance to make comparisons, have second thoughts, and adjust the weights. Then, to stimulate students to scrutinize their values more closely in a clearly playful and gameline (nonthreatening) context, they are confronted with a series of values dilemmas. The first step is to choose between hypothetical occupations that represent a pure manifestation of each value.

FIGURE 2

Welcome to the Strive Employment Agency

The jobs currently available are listed below

TORPIST

(1) Torpist is a choice job for a person who values leisure strongly. The hours are short, the schedule has been arranged to provide for a four day work week, the annual paid vacations are long, and every national and state holiday is observed, giving you many extra long weekends. As a result, you have lots of free time to follow your own interests.

(2) VARISATOR

Varisator is a great job if you want variety. You work with your hands, adjusting the varimeter, or with your brains, solving the priority flow. You travel, work with people, work alone, deal with varied tools and problems. If routine is your enemy, this is the job for you. But you need a cool head, for you never know what will come up next.

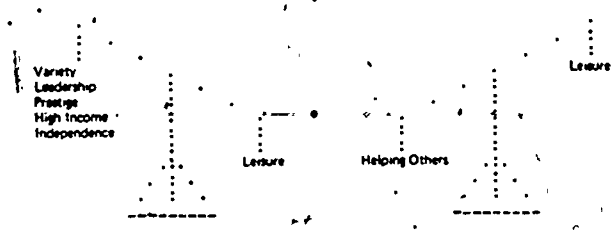
Press (1) or (2) to show which job you prefer

Having made a choice, the student finds--as in the real world--new decisions to be made. A series of problems or opportunities, each featuring a different value, is encountered. For example, the occupation chosen may be deficient in opportunities for leadership; or there may be a temptation to move to an occupation offering higher income. The decision to stay or switch indicates the relative importance, to this student, of the two competing values in a given context.

At the end of each round of the game, the student sees a display in the form of a balance scale.

FIGURE 3

This ends your career as torpist, featuring the Value leisure



Look at the balance scales above. Your choices in the game suggest that leisure was more important to you than any of the Values on the left side of the scales.

Press NEXT

Now look at the balance scales above. Your choices in the game suggest that leisure was LESS important to you than the Values on the left side of the scales.

Press NEXT.

The game is intended to stimulate further thinking about values, and the student is not held accountable for inconsistencies. Students' own evaluations of their inconsistencies show up when (after completing as many rounds of the game as they wish) they reweight their values.

FIGURE 4

WEIGHT (IMPORTANCE): None, Slight, Medium, Strong, Highest

VALUES	Weight
(1) HIGH INCOME	6
(2) PRESTIGE	3
(3) INDEPENDENCE	5
(4) HELPING OTHERS	2
(5) SECURITY	6
(6) VARIETY	4
(7) LEADERSHIP	5
(8) INTEREST FIELD	6
(9) LEISURE	5
(0) EARLY ENTRY	3
	Sum = 45

SECURITY Freedom from fear of losing job or income. You cannot be fired easily. Employment high even in recessions, no seasonal ups and downs. Income stable. Occupation not likely to be wiped out by new technology.

To ADD a point to the Value you have chosen, press the number 1
To SUBTRACT a point from that Value, press the number 0

Press 1 to add or 0 to subtract as many points as you want
When you are satisfied with the weight you have given that Value, press NEXT

A new constraint is introduced here: to distribute a fixed sum (40 points) among the 10 values. This constraint reflects the sad truth that one can rarely expect to get all of everything desired in the real world. Hard choices must be made--to give up a little on one value in order to retain more on a value of greater importance. The result of the adjustment is a profile of the student's "examined values."

LOCATE. The student puts in specifications on any five values at a time. The computer uses these specifications to screen the occupational data and instantly display on the screen a list of occupations that meet or exceed the specifications.

FIGURE 5

Values for locating occupations

Income
More than $12,000

Security
An average amount

Independence
A more than average amount

Interest Field
Technological

Variety
A more than average amount

These occupations meet your specifications.

Broadcast Technician
Chemical Engineer
Civil Engineer
Industrial Engineer
Electrical Engineer
Meteorologist
Mechanical Engineer

For a copy of this information, press PRINT, otherwise press NEXT

The student can change the specifications, and can substitute other values, to generate additional lists of occupations that are worthy of further consideration.

COMPARE. The student can then ask pointed questions about any three occupations at a time. The occupations can be chosen from those suggested in Locate, or from the entire list of occupations in SIGI at a given time. The questions cover such topics as work activities, entry requirements, income, personal satisfactions, conditions of work, and outlook.

FIGURE 6

Now you can get information about the three occupations.
Press the number for the question you would like to have answered
(After you get the answer you can keep coming back to this list to ask more questions.)

DEFINITION AND DESCRIPTION
(11) Definition of occupation?
(12) Description of work activities?
(13) Level of skill in interacting with data, people, things?
(14) Where to get more information?

EDUCATION, TRAINING, OTHER REQUIREMENTS
(15) Formal education beyond high school?
(16) Specific occupational training?
(17) Related college courses?
(18) Personal Qualifications?
(19) Other requirements?

INCOME
(20) Beginning salary?
(21) Average income of all people in this occupation?
(22) Top salary possibilities?
(23) How salaries vary?

PERSONAL SATISFACTIONS
(24) Opportunities to help others?
(25) Opportunities for leadership?
(26) What fields of interest?
(27) Prestige level?

CONDITIONS OF WORK
(28) Physical surroundings?
(29) Leisure (hours)?
(30) Independence on the job?
(31) Variety?
(32) Fringe benefits?

OPPORTUNITIES AND OUTLOOK
(33) Employment outlook?
(34) Where are the jobs?
(35) Job security?
(36) Advancement?
(37) How many women?

The information stored in the computer and used to answer these questions was gathered from many sources, carefully interpreted, reconstructed, and documented by SIGI staff members, then reviewed by specialists in the respective occupations. Although national rather than local information is presently used in SIGI, all national data are checked against representative regional and local data; an effort has been made to incorporate regional differences when they are significant. Local information will be added later.

PREDICTION. To help students judge their chances of success in the various programs offered at a college, they are given probability statements based on marks obtained by previous students. More specifically, students see an estimate of their "chances in 100" of getting a given mark (e.g., A, B, C, etc.) in the "key course" for each program. Ideally, a key course is defined as a course that comes early in a sequence of courses for a program, is required for that program, and differentiates students who do well from those who do poorly in that program.

The data used for predictions are, of course, unique to each college. Predictor variables include test scores only if a college requires tests of all students; in any event, students also enter relevant information about themselves and rate themselves on factors which have been identified as predictive of marks in each key course. The best combination of predictors (often including the student's own "informed estimates" of marks in the courses) is stored as a regression equation from which each student's predictions are computed on-line.

FIGURE 7

MAJOR FIELD PROGRAM	Chances in 100 for GPA of: 4.0-3.0 A B	2.9-2.0 C	Below 2 Below C
Hum &Soc.Sc.	05	35	60
Data Proc.	15	50	35
Acctg.	30	50	20
Engr. Sci.	15	40	45
Drafting	10	40	50
Biology	10	50	40
Arch.Tech..etc	20	40	40
Electronics	35	40	25

When you have finished, you can get a copy of this chart
For a copy, press PRINT.
Otherwise, press NEXT.

PLANNING. This section helps students see how to get from here to there for any occupation in SIGI that they may be considering. They are shown the requirements for entry and judge whether they are willing and able to meet them. If they are undecided, they see displays of the rewards and risks of trying the program for that occupation for a semester or switching to another program. They can then see an overview of a complete plan for entering the occupation, followed by a specific semester-by-semester course of studies recommended at their own college.

FIGURE 8

A suggested ENGINEERING SCIENCE program includes:

FIRST SEMESTER
EG 101 Language & Lit I
MA 111 Math Analysis I
CH 101 General Chemistry
EN 103 Engineering Graphics
PH 103 Univ Physics I
MA 113 Computer Program I
EN 501 Engineering Orient
Health & Phys. Ed

SECOND SEMESTER
EG 102 Language & Lit II
MA 112 Math Analysis II
CH 102 Gen. Chem. & Qualitative Analysis
EN 106 Descriptive Geometry
PH 104 Univ. Physics II
MA 114 Computer Program II
Health & Phys. Ed

THIRD SEMESTER
MA 211 Math Analysis III
PH 213 Univ Physics III
CE 205 Statics
Soc. Sci Elect
Technical Elect.

FOURTH SEMESTER
MA 212 Math Analysis IV
PH 214 Univ. Physics IV
CE 206 Dynamics
Soc. Sci Elective
Technical Elective

For a copy press PRINT, otherwise press NEXT

If transfer is required, students get information about colleges in the region that offer a major appropriate for the occupation they are considering. They can also summon up extensive information about financial aid.

STRATEGY. This section brings together students' values, occupational information, and predictions for three occupations at a time. The weights previously assigned to values are retrieved and may be revised to show the current importance of each value. SIGI then displays a rating that represents opportunity offered by each occupation to provide the reward or satisfaction represented by each value. The weight for each value (showing its importance to the student) is multiplied by the rating (the degree of opportunity offered by the occupation); the sum of these products for each occupation provides an index of its over-all desirability for that student.

Desirability is then modulated by the probability of success in entering the occupation. Students scan the steps necessary for entry and estimate these probabilities. Finally, they examine their choices in the light of these relative risks and rewards; for example, if the occupation with the highest desirability does not also have the highest probability, is the higher reward worth the extra risk? Thus, students evaluate their choices and explore alternative strategies for choice.

What hardware and software are used for SIGI?

SIGI is written in BASIC-PLUS, an extension of Dartmouth BASIC, designed for operation on Digital Equipment Corporation's PDP-11 family of mini-computers under the RSTS/E time-sharing monitor. Multiple SIGI terminals are supported on a small RSTS/E configuration built around the PDP-11/40 processor with removable mass storage. With additional core storage and mass storage, the RSTS/E time-sharing system can support concurrent operation of other standard terminals as well, up to a maximum of 17 (SIGI plus non-SIGI). Configurations built around larger processors, such as the PDP-11/45 or PDP-11/70, can support up to 64 terminals.

The terminal by means of which SIGI interacts with the user is a high-capacity cathode-ray tube display and keyboard, with an associated low-speed printer. Terminals may be located near the processor, or may be operated over telecommunication links at remote sites. A single RSTS/E configuration can support a mix of local and remote terminals. SIGI terminals may be used for other tasks under RSTS/E when not in use for SIGI.

Will SIGI replace counselors?

SIGI is planned to fit into the regular guidance programs at a school or college. It will not supplant counselors. Rather, it will complement the work of the guidance staff.

SIGI does superbly some things that human counselors cannot do efficiently, or at all. It stores, retrieves instantly, and manipulates vast amounts of information putting great resources at the fingertips of each student, tailored to his or individual needs. It brings together many sets of variables--personal, occupational, and institutional. By combining these sets of variables in distinctive ways for each student, it constructs new and unique information--as illustrated in the description of Locate, Prediction, and Strategy.

On the other hand, SIGI does not attempt to do what many counselors do superbly. It does not provide a warm human relationship; it does not try to solve personal, social, or academic problems; it does not attempt to cope with emotional upsets.

There are, however, ways in which the counselor's work may articulate quite closely with SIGI. The Counselor's Handbook for SIGI suggests how the counselor can capitalize on students' experience with SIGI. SIGI may stir up concerns which the student will want to discuss with the counselor. Furthermore, while SIGI deals with occupational decision, it does not include information about specific local jobs within an occupation. A counselor or placement officer may apply many of the paradigms used in SIGI to students' choosing and seeking jobs within each locality. Thus, working together, the counselor and SIGI can help students much more than either could manage independently.

THE COMPUTERIZED VOCATIONAL GUIDANCE SYSTEM - VOCGUYD

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ABSTRACT: Emphasis is placed on the importance of suitable career choice and planning for the happiness and productivity of individuals, and in the need for decision competency development as a necessary requisite for making a career choice. A self developed profile of both school and work special aptitudes, with an indication of work value embraced serves as the model for selecting a concert of up to eighteen criteria to be used by the computer in narrowing career choices from the many to a few. When a particular career job of interest is identified the computer proceeds to interrogate the participant to determine the degree of agreement between the world of the individual and the requirements for success in that job. A Career Success Index (CSI) is provided the individual depicting this agreement. Each participant is expected to secure from 4 to 6 jobs with a CSI of average or better for purposes of more concentrated study under a Guidance Counselor.

<u>The Computerized Vocational Guidance System</u> (VOCGUYD) is designed to relate the world of an individual to the world of work in a meaningful yet comprehensive manner. It is intended for use by individuals in their own life career planning, and is designed specifically to provide a scientific means for reducing of career planning choices from the "many-to-the-few". The few would then be studied in more concentrated way with the assistance of a Vocational Guidance Counselor. It serves as an effective vehicle to foster career maturity in individuals by providing "information about" through use of Computer Assisted Instruction (CAI) auxiliary guidance programs, and "experience with" through Search and Screening criteria involving fundamentals critical to real job success.

Computerized Guidance Programs

VOCGUYD is a revised and completely updated version of an older program by a similar title for which the author has served as the major architect over the past decade at THE UNIVERSITY OF WISCONSIN (now retired). It is one of a series of computerized guidance programs developed largely by the author, all of which are intimately related to effective career planning through the development of "career-maturity":

- .. EDGUYD - The Computerized Educational Guidance System.
- .. DEDEV - The Computerized Decision Development System.
- .. HUMRELAT - The Computerized Human Relations System.
- .. PLUDRUG - The Computerized Drug Abuse Education System.

Just as one would not expect an individual to play classical music on a piano unless indeed one has already learned to play the piano; so one can not expect an individual to do effective career planning unless that person has already developed competency in scientific decision making. DEDEV is intended for use in developing improved competency in decision making. Similarly, marketable skills necessary for job success in any career are the product of a school or an educational experience, and EDGUYD is intended for such planning. The real critical keystone to job success and progression remains successful interaction with people, and HUMRELAT is intended for the development of "career maturity" in this arena. Finally, personal satisfaction of individuals is largely dependent on finding new and better ways for turning-on; even in the face of adversity-PLUDRUG is intended for use in accomplishing this objective. PSYCHIC - The Science of Psychical Activity has been developed in an experimental form, and seeks to introduce the realm of Transpersonal Psychology to the career planning arena.

World of Work

VOCGUYD contains all of the 1326 job titles included in The Occupational Outlook Handbook for 1974-75 together with their major "shredouts" (instead of one nurse, for example, there are several different specialties in nursing, etc.). Two major types of such shredouts are involved:

.. SPECIALTIES - within same career field of nursing, for example, we might include psychiatric nurses, public health nurses, general nurses, etc.; for airplane engine mechanics we might have B-52, DC-9, A-111, Rockets, etc.

.. LEVELS - different skills within the same career field, for example, may involve a reading teacher with 2 years of college preparation, with second being a regular elementary school teacher, and still another being a highly eminent college or university professor. It may be a professional athlete in relation to a college athlete, and where acceptance of pay is the discerning variable, for another example.

Based on the 22 Job Skill Requirement Areas contained in The Dictionary of Occupational Titles (DOT) the VOCGUYD job titles are distributed as follows:

No.	Job Skill Area	Number	%age
1	Art	52	03.9
2	Business	46	03.5
3	Clerical	106	08.0
4	Counseling,Guidance,Social Wk.	33	02.5
5	Crafts	109	08.3
6	Education and Training	48	03.6
7	Elemental	217	16.4
8	Engineering	130	09.8
9	Entertainment	46	03.5
10	Farming,Fishing, & Forestry	69	05.2
11	Investigation, Inspection,& Tstng	56	04.2
12	Law and Law Enforcement	32	02.5
13	Machine work	59	04.4
14	Managerial and Supervisory	59	04.4
15	Mathematics and Science	36	02.7
16	Medicine and Health	58	04.3
17	Merchandising	19	01.4
18	Music	13	00.9
19	Personal Services	57	04.3
20	Photography and Communication	56	04.3
21	Transportation	07	00.5
22	Writing	18	01.4
	TOTALS	1326	100

World of Individual

The world of the individual, for purposes of VOCGUYD, is comprised of 18 different criteria which are designed for Search and Screening (S&S) among the 1326 job titles, representing the world of work. Each of these criteria deals squarely with some consideration deemed critical to job success. A five area classification is used to depict these dimensions:

I. PERSONAL INTEREST - this includes seven different occupational interest classification schemes and inventories.

II. SCHOOL APTITUDES - three special aptitudes related to school success.

III. WORK APTITUDES - three special aptitudes related to work success.

IV. WORK VALUES - the four work value areas from Super's Scale.

V. SCHOOL SUCCESS - Grade Point Average or the average grade given.

Requisites for VOCGUYD

While the general subject of career guidance is of concern beginning with kindergarten and through old age, the more serious business of career selection is typically associated with high school experience.

Critical Nature

Career maturity on the part of an individual deals squarely with one's recognition of the real importance for career planning and preparation. It is typically during junior high school when career maturity receives prominence in the school guidance program. Second only to the selection of one's mate is the matter of proper career planning and actual career choice. Most of personal adjustment problems may be traced in part to faulty career planning, or development, and the absence of marketable skills to do the job.

Decision Competency

Unless an individual can demonstrate effective decision competency, one is not ready for the serious matter of career planning and selection. DEDEV - The Computerized Decision Development System is intended for use in fostering such decision competency in individuals. Just as one would not ask one to play Bach on the piano unless they demonstrate competence on piano;so one should not be expected to make sound career choices unless they can demonstrate competency in decision making.

School Relevance

Each and every individual must be considered to be one of a nation's "human resources", and to properly fulfill this mission in life it is most essential that one posess "marketable skills". The principal function of a school in relation to manpower-resources is, to be sure, the development of suitable marketable skills. When, and only when, school experiences are related directly to the development of marketable skills do the activities become meaningful in nature. Thus, there is a very direct relationship between career maturity and the perceived relevance of school experiences. Where such relevance for school experiences are not perceived beginning in the junior high school program, VOCGUYD may be utilized for this purpose.

The VOCGUYD Student Work Sheet

The VOCGUYD Student Work Sheet is a four page guide for the use of individuals desiring to use VOCGUYD, and it provides a functional index for each of the 18 different Search and Screening (S&S) criteria. It contains the "Self Projected Profile on Select Job Success Criteria" form which serves as an initial planning base, and with provisions to indicate criteria to be used in concert for four separate Search and Screening exercises on VOCGUYD.

This profile is intended as a functional part of one's own personal record.

Self Projected Profile

This profile provided on "The VOCGUYD Student Work Sheet" serves as a means for one's own personal assessment of special aptitudes and work values related to career success. Where such persons have taken appropriate standardized psychological tests, those scores may be used in the self-profile, i.e., The Differential Aptitude Test Battery (DAT), The General Aptitude Test Battery (GATB), Super's Work Value Inventory, to name but a few. Where no such scores are readily available or desired, the participant may make a personal estimate of what such scores might be in relation to typical individuals, and base the profile on that personal estimate:

.. SCHOOL SPECIAL APTITUDES

- Verbal Ability
- Number Ability
- Abstract Ability

.. WORK SPECIAL APTITUDES

- Clerical Ability
- Mechanical Ability
- Space Relations

.. WORK VALUES

- Material Wealth
- Good Life
- Self-Expression
- Behavior Control

.. SCHOOL SUCCESS

- Grade Point Average for High School
- Grade Point Average for Senior Year
- (Other GPA's substituted as needed)

Personal Likes Pattern

The "Personal Likes Pattern" (PLP) of an individual consists of from maybe 4 to 7 of the 18 different S&S criteria from VOCGUYD, and which are intended to reflect a rather accurate picture of the "world of the individual", and as the individual alone perceives it; not as the counselor, parent, or some other percieves it.

Emphasis in the development of the PLP is to be placed on personal interest, and with special aptitudes, work values, and even grade point average considered as being secondary in importance. Typically, the first criterion may represent one of the vocational inventories (Kuder, Ohio, HEW, etc.). A second criterion might be based on Roe's Socio-economic Hierarchy, i.e., professional, semi-professional, business, skilled trade, semi-skilled, or laborer. The third criterion might derive from the DOT Interest Areas, i.e., prefers working with data, persons, things, data and persons, data and things, etc. The fourth might deal with School Level for Job Entry, i.e., high school graduate, two years of college, college graduation, etc. For example, a Kuder (4), Roe (6), DOT Interest (2), and School Level (8) PLP depicts a career job with personal interest in persuasion, becoming a professional, working with persons, and doing graduate level schooling. It might include such jobs as: law, ministry, sales, acting, management, military, political, etc.

Narrowing of Career Choices

This represents the second stage in the use of VOCGUYD. Here the computer proceeds to relate the "world of the individual" as represented by the PLP with the "world of work" as represented by the 1326 job titles from The Occupational Outlook Handbook for 1974.

Search and screening function. It is very important that criteria in the PLP be arranged in order of importance as perceived by the participant with the most important one being first. Individuals should begin with no fewer criteria in the PLP than maybe 4 or 5. The computer applies the PLP as a single permutation in concert to determine if any of the 1326 job titles are congruent with the synthetic notion. If no job titles are found in the first iteration, or initial computer screening of the particular PLP, the computer advises the participant that the last, and least important criterion is being dropped, and automatically continues with a second screening. If no job titles are found congruent with the PLP in the second screening, the computer advises that the existing last criterion is dropped, and continues with a third screening. This precise same procedure is continued until either all criteria are expended, or some job titles are found with congruence to PLP being used. This computer based Search and Screening process is a "beauty to behold" that goes far beyond the capability of human counselors to "narrow job titles" from the universe of such listings from the "many-to-the-few" for more concentrated study.

Computer-based interrogation. When job titles are found that are congruent with the PLP depicted by the participant, the computer first indicates the number of such job titles, and asks if a listing of such titles is desired; or if another screening is desired. Where the participant asks computer to list job titles that are congruent with own PLP, such titles are listed in groups of 10, or fractions of 10, and asks if the person is interested in examining further any of the listed job titles. When an individual indicates an interest in one of the titles, the computer proceeds with the second stage in the "narrowing of choices" which is a "computer-based interrogation". Here, then five different questions are asked, each one bearing directly on conditions essential for expected success in such job experience. For each question a percentage of weight has been assigned that is commensurate to the importance of the condition stipulated, and ranging from 1 to no more 35 percent. The total for all five questions is always 100 percent. For example, if an individual does not wish to complete college, but indicates in the PLP that a semi-profession is desired, the particular question would count 35 percent against congruence, and as reflected in the "Career Success Index" provided.

Career Success Index

The Career Success Index (CSI) is a number that depicts the degree of agreement between the world of the individual and the requirements for the specific job title at hand. Adjectives used by computer to report this congruence range from "poor" through "low" and "high" average to "above average" and "superior". The CSI is presumed to be an empirical measure of expected success for an individual. The notion of basis for success rests squarely on personal interest of an individual, and with the belief that there is little personal motivation present unless one is interested in the requirements that characterize the job. For example, if one selects the job of Forest Ranger, but answers negatively in relation to desire to work in the outdoors, such person is not likely to find personal motivation in such job activities. Therefore, it follows logically, that the first and basic requisite for job success remains the personal interests and work values of the individual. Where the CSI for an individual is "average" of better, it is suggested that a deeper study be made of such job area with the aid of a Vocational Guidance Counselor. It is suggested that each participant in the serious business of job-career planning try to secure 4 or 5 job titles for which there is average or better congruence as indicated by the CSI. A more careful and detailed study of such jobs should seek to rank them in order of the preference perceived following such study, but with no intention of reducing the choices to a single career choice until after maybe two or more years of college; or for the non-college person, until after marriage or adult settlement.

Suggested Uses of VOCGUYD

The overall purposes of VOCGUYD is to assist individuals narrow their choices from the many-to-the-few in terms of career choices.

Developing Career Maturity

VOCGUYD is recommended for use by students in the fifth or sixth grade, or for use in junior high school for purposes of developing "career maturity". Here groups of from 5 to 8 individuals may work around a single cathode ray tube (television set) or teletype for use of VOCGUYD. One of the persons with reading competency at the fifth grade level or better operating the typing for communicating with the computer. The operating of the typing may be rotated from one person to another, but with the entire group participating in the discussions and choices.

In this manner all participants deal with critical criteria in relation to job success, and through the experience gain improved career maturity. For example, the son or daughter of the village physician, who are fully intent on becoming physicians themselves, may use VOCGUYD along with other similar individuals-even if they are all high school seniors. Here the intent is not to reduce career choices from the many-to-the-few, but rather to foster career maturity.

Precise Career Planning

This, to be sure, is for the individual that is concerned with precise career planning, and desires to narrow career choices for more intensive study of a select few job career areas. The VOCGUYD Student Work Sheet should be used for planning and record keeping purposes. While other persons may be involved as observers, only the participant alone elects the choices and operates the computer CRT or teletype station. Generally, the objective is to identify 4 or 5 job titles for more intensive study with an average or better CSI.

VOCGUYD Computer Adaptations

VOCGUYD has been developed largely under Federal monies and is therefore considered to be "public read" status. The computer program (software) is available free except for the cost of shipment and putting it on tape or cards.

Presently, the program is operational on the UNIVAC 1100 series, and the DIGITAL PDP/1145 and DEC 10. It has also been run on the HONEYWELL 6000. It is written in both Extended Basic and FORTRAN V. About 20K of computer memory is required for such storage. The source deck contains about 900 IBM cards, and the data about 11,000. The author is in the process of adapting VOCGUYD and the other computerized guidance programs on a microcomputer with an 8080A computer chip, i.e., ALTAIR 8800, and EMSAI. It is hoped that this new adaption will be operational for September, 1976, but this is admittedly an ambitous plan. It is hoped that such computer may be purchable for $5,000 or less with the miniature peripherals necessary to handle the programs.

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THE COMPUTERIZED EDUCATIONAL GUIDANCE SYSTEM - EDGUYD

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ABSTRACT: This program is a computerized means for assisting individuals in their post high school educational planning. All 1448 accredited four year colleges in the United States as indicated in Barron's Profile of American Colleges - 1975 are included. The Marketable Skills Inventory (MSI) serves as the initial planning base for use of EDGUYD. Here the participant first draws a profile on a stanine scale indicating what one believes to be their present development on 40 different marketable skills, and then a second profile indicating where they desire to be. The "Difference" score between the two profiles depicts where schooling is needed to meet personal objectives. Eleven Search and Screening criteria are included on The EDGUYD Student Work Sheet for use in concert to identify a job career area that is congruent with one's Personal Likes Plan (PLP). When a college or university of interest is identify in the screening, computerized interrogation proceeds to determine agreement between school conditions and the likes of the individual involved. An Educational Success Index (ESI) is provided depicting congruence between desires of individual and school conditions.

The Computerized Educational Guidance System-EDGUYD is designed primarily to assist individuals in their planning for post high school educational activities in relation to four year colleges and universities. It provides an effective scientific means to consider all 1448 such institutions in the United States when narrowing one's choices from the many to the few. The few colleges that agree with one's interest pattern would then be examined in more concentrated fashion under the help of a Guidance Counselor. Emphasis is placed on "marketable skill" development as a means for fostering relevance to educational experiences, and to generate motivation for educational pursuit by participant.

Junior Colleges Eliminated

All of the 1448 four year or "upper division" colleges and universities included in Barron's Profiles for American Colleges (1975) are included in EDGUYD. Junior colleges and other post-high school opportunities were excluded for a variety of reasons. Generally, post-high school educational offerings except for the four year colleges and universities remain a local and community enterprise, tailored largely to needs of local personnel, and with promotional programs for these enterprises. Typically, high school seniors are quite familiar with such local programs, including the community junior colleges, and do not need computerized screening for such purposes, i.e., barber, nursing, mortician, data processing, business, technical schools, etc. More-often-than-not few persons from outside of the immediate district attend such local enterprises.

Computerized Guidance Programs

EDGUYD is a revised and completely up-dated version of an older computer program with a similar name. In addition there are several other highly related programs for which the author has been the major architect over the past decade at THE UNIVERSITY OF WISCONSIN (now retired):

.. VOCGUYD - The Computerized Vocational Guidance System.

.. DEDEV - The Computerized Decision Development System.

.. HUMRELAT - The Computerized Human Relations System.

.. PLUDRUG - The Computerized Drug Abuse Education System.

.. PSYCHIC - The Science of Psychical Activity.

Extension of Career Guidance

Meaningful educational guidance follows logically the planning for marketable skill development in relation to career job choices. On the other hand, the purposes for marketable skills is job productivity; for national productivity derives solely from manpower guided resources, and which in turn is dependent on the educational development of people. If, then, curriculum offerings beyond the junior high school are to have relevance to the students, they must inevitably be related to job and career planning. In addition, a nation's productivity and general welfare of its people are both highly related phenomena, and effective educational planning and development is the necessary requisite for both of them. When one's productivity is low, there is little or no job progression present, and where there is an absence of progress there is generally low morale of persons involved. Where morale is low, there tends to be high unemployment, divorce, crime, drug abuse, and all of the other social evils.

Search and Screening Criteria

The world of the individual in relation to post high school education planning by use of EDGUYD is represented by 11 different Search and Screening criteria (S&S). Each of these criterion may be critical to some aspect of college or university selection by an individual. Any one or all of the criteria may be used by a participant in college or university selection. These criteria are as follows:

(1) LOCATION - state or location, i.e., Maine, Texas, Oregon, etc.

(2) TYPE - nature of organization, i.e., liberal arts, university, fine arts, etc.

(3) STUDENT BODY - distribution of students by sex, i.e., co-ed equal sex distribution; co-ed mostly male, etc.

(4) CONTROL - budgeting and administration, i.e., state, Catholic, Protestant, etc.

(5) ADMISSIONS - requirements for student admission, i.e., most competitive, highly competitive, etc.

(6) ENROLLMENT - number of students attending, i.e. very large-over 10,000; large-from 5,000 to 9,999; etc.

(7) TUITION - annual cost for attendance, i.e., over $4,000; less than $500, etc.

(8) COMMUNITY - type of place where located, i.e., metropolitan and upwards of 100,000 population; rural; etc.

(9) DEGREES - college degrees conferred, i.e., A.A.; B.S.; M.S.; etc.

(10) SCHOOL TERMS - quarter, semester, etc.

(11) SPECIALTIES - critical school special offerings, i.e., Bible study, Asian studies, etc.

The Marketable Skills Inventory

The Marketable Skills Inventory (MSI) is a student work sheet intended as a necessary requisite for use of EDGUYD. It is intended for use in assessing need for educational pursuit, and to foster motivation on the part of participant by focusing squarely on purpose for schooling. Ten different broad areas with sub-categories of marketable skills are listed, followed by a nine point rating scale (stanine). Fourty different skills are listed that are believed to be directly related to certain aspects of job and career success, largely exclusive of the technical knowledge and skills typically associated with job preparation and entry:

I - COMMUNICATION - self-expression, listening, cybernetic involvement, and hidden communication.

II - ASSESSMENT - arithmetic, statistical manipulation, and irreality and objectivity.

III - COGNITIVE - creative and abstract, hypothetico-deductive, and analogies testing.

IV - DECISION MAKING - locus of control, models of excellence, systems analysis, vector and valence analysis, and wedding activity to purpose.

V - EGO DEVELOPMENT - discerns sympathy from empathy, vantage economic manipulation, self-actualization sensitivity, and perception of freedom levels.

VI - HUMAN RELATIONS - personal attraction dynamics, personal rejection dynamics, reconciling confrontation, and leadership development.

VII - VOCATIONAL SKILLS - mechanical, clerical, space and artistic literacy, musical playing and listening, and dance and rhythm.

VIII - AVOCATIONAL SKILLS - N-achievement presence, leisure time involvement, and health and physical status.

IX - VALUES - dignity/worth of person, equality of individuals, democratic principles, and religion and morality.

X - REALITY LEVELS - autogenic or biofeedback, transcendental sensuality, transcendental meditation, select parapsychology areas, and individual aura implications.

To complete the MSI an individual is expected to make own personal assessment of the degree to which each of the 40 marketable skills are presently posessed, and then to draw a profile on the nine point stanine scale provided. Following this a second profile is drawn for the same 40 skills using same stanine scale and depicting own desires for levels of development in each area. Following the drawing of the two profiles (percieved status in relation to desired status on the 40 marketable skills), a "D", or difference score is computed depicting clearly educational needs in relation to each of the 40 marketable skills. Thus, educational planning is based on perceived needs of individual, and curriculum offerings take on new meaning of relevance.

The EDGUYD Student Work Sheet

The EDGUYD Student Work Sheet is intended for use by students planning to use EDGUYD, and in developing readiness for the computer application. It serves as the basis for relating the world of the individual, as depicted by the 11 S&S criteria, to the total number of colleges and universities in the United States (1448 from Barron).

Personal Likes Pattern

The Personal Likes Pattern (PLP) of an individual in relation to a college or university for attendance is based on a concert of the 11 Search and Screening (S&S) criteria. Space on The EDGUYD Student Work Sheet contains provisions for four separate PLP's. Thus, an individual is able to make four separate narrowing of choices from the 1448 four year colleges and universities to a few for more intensive study under the supervision of a Guidance Counselor.

The PLP may consist of any number of S&S criteria. Typically, one would use one of the interest inventories (HEW, Kuder, DOT, or Ohio) as the initial criterion. This might be followed by tuition or admissions policy, depending on the facts of individual involved-if, for example, the individual came from a wealthy family where money is of little concern, tuition may not be used. If, on the other hand, the Grade Point Average (GPA) of the individual were so low that Ivy League and competitive universities would not admit one, then "admission policy" would be a MUST. This might be followed by type of university, if one were interested in music or fine arts, or maybe in technology. Where religion is a critical aspect of one's PLP, certainly Institution Control would be included. For many individuals, the size of the college enrollment, or size of the community in which the college is situated may be critical. For still others, the sex distribution of student body, type of degree granted, or kind of school term may be important.

Typically, five or more S&S criteria would be included as the PLP, and for S&S purposes in EDGUYD. Such a PLP on The EDGUYD Student Work Sheet might be as follows: 104,202,304,406,505, 705. This is interpreted as an institution located in California (104), a liberal arts college (202), women students with few males (304), Catholic religion control (406), less competitive (505), and tuition from $500 to $1450 per year (705).

Narrowing of Choices

There are two separate and distinct stages involved in EDGUYD for the narrowing of choices from the many to the few. Each of these stages seeks to determine more precisely the degree of congruence between the "world of the individual" and the conditions and requirements relative to a college or university for personal attendance.

Search and screening. Here the PLP's developed by a participant are inserted one-at-a-time. All 1448 colleges and universities are considered in the S&S, unless one of the criteria limits the search to a particular state. For example, if one were to use the S&S 132, only colleges and universities in New York State would be included. If, then, no institutions were identified in the first iteration of the search, the participation could write into the computer "-132", and the second iteration of the search would include all of the colleges and universities in the United States. If, then, one desired to eliminate New York State, but include California instead, they would write: "-132, 104", and the next iteration would use the same PLP, but only with colleges and universities in the state of California. Such changes may be made for each succeeding iteration, or Search and Screening function for a single PLP in EDGUYD.

Where no institutions are identified in a S&S iteration, it is, of course, necessary to eliminate one or more of the S&S criteria; as the PLP does not fit any of the institutions included. This is done immediately after such an iteration, and by simply typing a minus (-) sign before the S&S criteria to be eliminated. One should weigh very carefully which one of the S&S criteria that is eliminated in order to identify an institution that best fits the PLP developed. The more S&S criteria included in the PLP, the fewer institutions one would expect to find.

Computer interrogation. The second stage in the narrowing of choice process always involves a computer interrogation phase. This stage can be accomplished only when one or more institutions have been identified that match precisely the PLP utilized in the first stage. After the computer has identified 1 or more schools that fit one's particular PLP, the computer indicates the number of institutions found, and asks if participant desires to see the names of such institutions; or desires to use another PLP for S&S purposes. If the individual asks computer to "List" the ones identified, the names and state of location are displayed in series of 10, and with the computer asking if there is a special interest in any one of them. If no interest is indicated in the first 10, the computer may be asked to list the remaining ones.

When the individual sees the name of an institution that is of interest, and gives the number of the institution to the computer, the computer interrogation proceeds. Here five different questions are always asked, and the participant indicates a "yes" or "no" as the conditions that are cited are acceptable. Such questions always pertain directly to the particular institution at hand, and range from number of books in the library, through pay of faculty, presence of graduate students, philosophy of school-no drinking or smoking by students, no eating of meat, compulsory attendance at chapel, no permission for cars by students, compulsory dorm living, absence of organized athletics, absence of fraternities or sororities, etc. Each question is assigned a number indicating its importance in relation to the university or college involved, but in no case is the number greater than 35 percent. The total for all five questions adds up to 100 percent.

Educational Success Index

The Educational Success Index (ESI) is a number with an adjective rating ranging from "poor success" to "superior" depicting the degree of agreement between special requirements for the institution and the desires of the participant. Where the ESI is "average" or better, the person should do a more concentrated study of the institution with the aid of a Guidance Counselor. Typically, a participant in the serious business of selecting post high school educational opportunities, should use EDGUYD to identify maybe 2 or 3 institutions with average or better ESI's for the more concentrated study purposes.

Suggested Uses of EDGUYD

There are, to be sure, many highly specialized aspects of guidance in regards to the lives of individuals. These areas might include the whole gamut of personal concerns, such as personal, sex, economic, family, career, among still others. All of these are intimately related, and often there may be considerable overlap among them. Educational guidance deals squarely with each one of these, and none of them should be excluded.

Developing Career Maturity

Educational guidance, too, is intimately related to the "career maturity" of individuals, and may be utilized for fostering this objective. Beginning about early junior high school (7th grade) career maturity assumes critical importance, and serves as a necessary requisite for relevance of school and curriculum offerings. For this purpose it has been found effective to have maybe from 6 to 8 persons working on the same teletype in the use of EDGUYD. The slow working teletype with the sound of typing gives the feeling of being alive to such younger students. For the older high school student the Cathode Ray Tube (television set) that is made to operate much faster is often better.

In the developing of career maturity the discussion of the computer interrogations serves to focus attention on critical factors related to varying institutions, i.e., tuition variable, type of institution, control, degrees offered, etc. Here "experience with" critical phenomena in relation to educational guidance becomes the rule, and which is so necessary for career maturity.

Auxiliary Guidance Programs

Both EDGUYD and VOCGUYD have a series of Computer Assisted Instruction (CAI) programs that deal with critical factors in relation to both educational and vocational guidance. Such CAI programs offer participants an opportunity to learn about these critical factors directly through computer interaction, and, thus, eliminating the problem of going to library and trying to find such information.

EDGUYD. This includes units on critical factors related to educational guidance. For examples, some of the characteristic testing batteries are described, i.e., Iowa Tests of Educational Development, Scholastic Aptitude Test Battery, Merit Scholarship Examination, etc. It includes in addition such things as: I.Q., Mastery Learning, Grade Point Average, among others.

VOCGUYD. This includes units on critical factors related to vocational and career guidance. For examples, it includes a description of some of the group tests used in career guidance: General Aptitude Test Battery, Differential Aptitude Test Battery, among others. It includes a description of each of the S&S criteria used in VOCGUYD, and such other phenomena as: job satisfaction, women and career planning, among others.

Precise Educational Planning

Each and every individual has a right to be able to consider all post high school educational opportunities for their particular personal planning purposes. That, then, is the purpose for which EDGUYD was designed, and principal use for EDGUYD. Here each person plans own PLP pattern by use of The EDGUYD Student Work Sheet, and then proceeds to the computer for the S&S function. In the S&S function, only the participant alone is involved in making the choices. In theory the participant seeks to obtain from 2 to 4 colleges or universities with an ESI of average or better, and which will be studied in greater depth and concentration with the aid of a Guidance Counselor.

EDGUYD Computer Adaptations

EDGUYD has been developed largely under Federal monies, and is therefore considered to be "public read" status. It is available at no charge except the cost for punching cards or putting it on a magnetic tape. Presently, EDGUYD is written in both FORTRAN V, and Extended Basic programming languages. It has been adapted for running on both the UNIVAC 1100 series (1106, 1108, and 1110), and on the DIGITAL PDP/1145 and Dec 10 computers. The source programs include about 1000 cards, and the data about 11,000 cards. It requires about 20K of computer memory in addition to that required by compiler. This program has been completely updated for 1975.

Presently, the author is in the process of adapting EDGUYD, like all of the other referenced computerized guidance programs, for running on a microcomputer-an ALTAIR 8800, and an IMSAI with an 8080A Computer Processor Chip, and with 64K of 8 bit memory. Hopeful this adaption will be completed for September, 1976-but this is admittedly an ambitious goal. Hopefully, such computer can be purchased for $5,000 or less.

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THE WMVS/WMVT PROGRAM SCHEDULING SYSTEM

(An Overview and Developmental Perspective)

by

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ABSTRACT:

A system for the Librarying, Booking, and Scheduling of Public Television Programs has been developed at the Milwaukee Area Technical College for its Public Television Stations, WMVS and WMVT.

This system is in operation on MATC's Honeywell 6060 computer system.

Using this system, station management is able to dynamically maintain and query, via interactive timesharing dialogues, an IDS (Integrated Data Store) data base containing information pertinent to these and related operating functions.

Through this system, station management may also generate appropriate operating and reference reports as they are needed.

An off-line tape-resident Program Library is also maintained as part of this system and serves as the basis for a nationally distributed Library of Public Television Programs. This Library is now distributed quarterly on Microfiche to interested subscribers.

This report provides an overview of this system and relates the approaches used and the problems encountered in its implementation.

PARTITIONING COMMUNICATION NETWORKS: A COMPUTERIZED APPROACH TOWARD THE ANALYSIS AND DEVELOPMENT OF LARGE SOCIAL SYSTEMS

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ABSTRACT: Communication networks consist of the regular pattern of communication contacts which develop among people within a social system as they use various forms of communication (face-to-face conversations, memos, telephone calls, etc.) to accomplish certain activities. Information regarding the functioning of the various types of human communication networks is important since it can be used to understand the system's flow of information and to assess its effectiveness and efficiency.

A formal algorithm for analyzing communication networks has been implemented in an extended FORTRAN program for the CDC 6500 computer. This algorithm can be realized on any large, general purpose machine, and it far surpasses any other similar analytic technique, that the author is aware of, in terms of utility, capacity, and efficiency.

The goals of network analysis are (1) to detect and (2) to describe any structure at the dyadic, group, or systems level of the network. The FORTRAN program provides additional information with regard to connectedness, integrativeness, etc. of individual nodes as well as entire groups for networks of up to 4,096 people.

The article describes a set of procedures for analyzing such communication networks in large systems. These include (1) identification and evaluation of various kinds of networks, (2) assessment of the organizational hierarchy, (3) appraisal of various parts within the system, and (4) evaluating the individual and group communication behavior.

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Communication *per se* is a relatively complex social process with many dimensions. Essential functions in any social system are accomplished through processes of communication. These essential functions have been divided into three basic categories by Barnard (1938): (1) production, (2) maintenance, and (3) innovation. Although other scholars developed different schemes into which the functions of social systems can be categorized, members of all social systems engage in activities that resemble Barnard's thinking. These functions, however, can only be carried out through various forms of communication. If the researcher studies the forms of communication in which the three functions of production, maintenance, and innovation are inherent, it can then be said--within limitations--that the social system has been analyzed with regard to communication. Each time the researcher focuses on one of these three activities, as they are reflected within the realms of communication, he specifies a particular communication network. If one would superimpose all existing communication networks within a system, this overall network could be considered to reflect the communication behavior of a social system.

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One area in particular that provides insight into methods for describing large, complex systems is systems theory. Buckley (1967), for example, considers the notions of wholes, parts, structure, interdependence, etc. of primary importance. Similar emphasis can be found with von Bertalanffy (1940), Rapaport (1970), and others. The problem is, however, that a specification of how to find parts or "units of formative process' has not been adequately established and constitutes today one of the major issues in systems theory (Krippendorff, 1971). Network analysis attempts precisely to overcome some of these inadequacies and takes into account some of the notions that are central to systems theory.

The paper focuses on the techniques and methods underlying the generation and analysis of communication networks in large, complex social systems. Communication networks consist of the detected patterns of communication contacts among individuals within a social system. These contacts can be 'arrested' for analysis purposes by assessing the attributes of face-to-face communication, communication by memoranda, by telephone, by letters, etc. Pool (1973) has described networks as the thread that holds social systems together. The analysis of networks can thus provide descriptions and characterizations of the system's structure. It should be noted that the applications of the network analysis technique are appropriate to many forms of social systems such as organizations, villages, class rooms, entire industries, inter-organizational analysis, and others.

Relational Analysis

The basic unit of analysis in network analysis is a relationship between two system elements within the same system. The term relationship deserves some specific attention before presenting further concepts. Generally, in network analysis one is interested in dynamic, functional relationships, i.e., active interaction between the related elements. This kind of relationship, obviously, is of prime importance if one is to construct a network composed of relationships. Conceptually, the existance of a relationship between two elements is constituted by the recognition of some constraint which restricts the behavior at least minimally of one or both of the elements. Such a constraint suggests one other characteristic of a relationship, namely that of interdependence betwden the elements.

Social scientists frequently have urged the need for relational analysis by emphasizing the importance to turn away from monadic and aggregate data (Cf., e.g., Coleman, 1972; Rosenberg, 1972). The proponents of this approach to view 'reality' argue that the researcher not only manages to arrest data of two elements, A and B, as in the monadic analysis, but that additional information is added to the recognition of constriants or, generally, a relationship between A and B.

Four major properties of relational constraints can be identified: symmetricality, strength, specificity and transitivity. A relationship r is said to be symmetrical if ArB ("A is related to B") implies BrA. This relationship is asymmetrical if ArB does not imply BrA. Since it is usually assumed that communication is a two-way process, communication would be a symmetrical relationship between two people by definition. An asymmetrical relationship would merely indicate a one-way flow of influence or information.

Strength, as a second property of a relationship, is understood as the extent to which B is influenced by A (or A is influenced by B) in the relationship r in ArB. Other conceptualizations for strength can be operationalized as importance, intensity, influence, etc.

The specificity of a relationship expresses the entent to which the relationship is not able to be replaced by another relationship that would allow for the occurrence of the same behavior of the relational system as before. In relational expressions, if the r in ArB cannot be replaced by some other r, e.g., ArC, the original r is defined as being specific to A and B. In terms of organizational settings, it is easy to conceive of situations in which there is only one person that has specific information and where this person could not be replaced by another person in order to achieve the same, initially intended goal.

Transitivity, the last property to be presented for the purposes of this paper, of a relationship r is then existent when ArB and BrC together imply ArC. Consequently, r is said to be intransitive if the first two relationships do not imply the third relationship. In terms of a communication situation, a transitive communication relationship suggests that A influences B and B influences C, and that at least in part the behavior of C is influenced by A via B. Transitivity is one of the key features of most balance-theoretic conceptualizations of social relationships (Cf., Harary, Norman & Cartwright, 1965; Heider, 1958; Newcomb, 1953; Bales, 1950).

With regard to network analytic purposes, a system is viewed as a set of elements imbedded in a network of relationships. So far, the units of analysis, i.e. relationships, have been described and specified. Next, a collection of relationships constituting a network as well as the manner in which these relationships can be analyzed and described will be viewed.

Measurement and Data Representation

Network analysis allows the researcher to identify the communication structure of a social system (e.g., company, school, class room, village, 'invisible colleges'). The analysis is started by building the existing structure with the smallest units of analysis that constitute the input data. The smallest units of analysis are relationships or interactions or links. It is essential that these relationships within a social system are found and recorded. These relationships can take on various forms of interaction such as in face-to-face communication, telephone calls, communication via memoranda, letters, etc. The more interaction exists between two members of a social system, the stronger is their communication link. The overall communication structure of the system is determined by the recognized patterns of these communication links and their relative strengths.

The detected properties of each network give certain insight into the way in which communication flows within a social system. In order to find the communication links from these properties, a network analysis data gathering instrument is administered to all or a representative (Cf., Coleman, 1972) set of members of the social system to be analyzed. This instrument is used to determine, among other areas of interest to the researcher, the existence and strength of links (and, consequently, the lack thereof) between members of a social system. Each instrument anticipates minimally five basic requirements"

(1) a definition of the social system,
(2) a definition of the network type to be investigated,
(3) the identification of the respondent,
(4) the identification of the respondent's contact(s) or contactee(s),
(5) determining the strength of the link between the respondent and his or her contact(s).

A sample data gathering instrument is attached in the appendix from which all information can be transferred onto computer cards. Generally, the data are sequenced as follows: respondent identification (ID) number, the ID number of the respondent's first contact, the value for the frequency that communication link, the value for the communication strength of that link, the ID number of the respondent's second contact, etc. continuing, until all of the respondent's contacts have been recorded. Typically, the following format is used:

Columns:

1-2 Project identification code

3-5	Respondent's ID number
6-8	First contact ID number
9	Link value (frequency) for first network
10	Link value (importance) for first network
11	Link value (frequency) for second network (if needed)
12	Link value (importance) for second network (if needed)
.	.
.	.
$n_1 - n_3$	Second contact ID number
n_4	Link value (frequency) for first network
n_5	Link value (importance) for first network
.	.
.	.
etc.	etc. etc.

There are a few considerations that need to be kept in mind when considering data that become input for network analysis. First, it should be noted that a link is not necessarily to be understood like a relationship with all its characteristics. A link is merely an indicator of the existence of a relationship, obtained through the process of measurement.

Secondly, the properties of the type of relationship under consideration should be mirrored in the data; the data themselves do not constitute the properties or relationships.

Thirdly, the data can only be isomorphic to the real world to the extent to which the measurement process is precise, accurate and representative.

From Relationships to Networks

Although a general description of relationships has been presented, it is useful to view in some detail the historical development of relationships to networks before considering the configuration of a multitude of relationships as networks. Most concepts and methods related to communication networks have been developed by sociometricians as well as social psychologists. The literature dealing with sociometry is rather extensive and becomes quickly evident when familiarizing oneself with the review presented by Lindzey and Berne (1969). Not too many of these studies deal specifically with communication relationships and communication networks per se.

One way of representing a communication network is through the use of a sociogram (Moreno, 1934), in some way a form of graph theory (König, 1936; Harary, Norman & Cartwright, 1965). Moreno uses points or nodes that represent members in the network and connecting lines between these points express certain relationships. All nodes and all lines within a sociogram represent the structure of a system in terms of the recognized relationships. There are a number of rather severe limitations to the use of sociograms for a rigorous social scientist (Wigand, 1974b):

(1) The data input for sociograms does not allow for a multidimensional representation of the relationships among system members.

(2) The strength of a relationship is difficult to express and as N becomes larger, nearly impossible.

(3) Sociograms may be of some use for the representation of the system that is relatively small. As N becomes 50 or larger, there are severe spatial limitations to represent the system two-dimensionally. Consequently, it becomes increasingly difficult to produce and interpret a large sociogram.

(4) Few criteria, if any, exist that specify the length of a link or relationship, i.e. it is to be decided by the researcher whether the length of a link is to express the amount, frequency, duration or communication or a combination thereof.

(5) It is unclear how the analyst can specify the angles constituted by the incoming and outgoing links at a given focal node.

(6) With the availability of computers, the sociometric representation compares to being tidious, cumbersome and inefficient.

Conjointly with the development of sociometric and graph-theoretic representations of networks, one approach that overcomes in part some of the above mentioned limitations of sociograms is the use of matrix methods. Katz (1947), Festinger (1949), Chabot (1950), Luce (1950), Jacobson and Seashore (1951), Weiss and Jacobson (1955), and Weiss (1956) have utilized matrices to represent relationships in networks in which various techniques allow for the detection of groups or cliques as well as certain characteristics thereof. The analysis of networks through matrix methods are of utility as long as N remains small. Even the use of computerized techniques becomes prohibitively expensive when N becomes larger, if not impossible, when N equals, e.g., 100. With a N of 100, each of the 100 could communicate with 99 others. Consequently, 9,900 possible connections would exist. If N would be 5,000, nearly 25,000,000 possible links exist.

Another area that has contributed to the development of network analysis is that of small group research typically conducted in laboratory settings. This research is said to have started with Bavelas in 1948 and has led to numerous studies. Review of these studies and some criticism are presented by Glanzer and Glaser (1959, 1961), Shaw (1971), and Collins and Raven (1969). Some of the key concepts that emerge from small group research deal with task complexity, centralization and decentralization of networks, as well as various communication network configurations (e.g., wheel, circle, all channel, etc.). Some of the main criticism of small group research is that the research is artifically conducted in the laboratory and that the analysis may allow for generalizations within a specific group, but not for generalizations for the higher-level behavior of several groups or an entire social system or organization.

Social networks have been investigated with regard to rumor diffusion, diffusion of innovations, information flow and other communication aspects (Cf., e.g., Barnes, 1954, 1969a, 1969b; Bott, 1957; Coleman, Katz & Menzel, 1957; Mitchell, 1969; Rogers, 1973). Most of these studies were conducted in urban or national settings as opposed to strictly organizational settings.

An analysis technique of social systems that largely overcomes the above mentioned shortcomings is network analysis. It is directly complementary to the key notions of systems theory. Network analysis provides a specific method of handling the relationships in large, complex systems. The technique is described in the following section.

Network Analysis: The Technique

The unique characteristic of network analysis is the method by which communication groups are formed. The method considers first the entire pattern of relationships among individuals before a decision is made what constitutes a communication group (or clique or cluster). This implies, if persons in the network leave or if studies of the same network are conducted over several points in time, different communication groups are likely to be detected. The network analysis technique, then, divides the system into parts only after descriptive data are obtained such that this method of analysis can be regarded as reflecting more adequately emergent properties of a system than methods which merely impose a structure before the analysis begins. A priori decisions with regard to the partitioning of a system is inappropriate. It becomes quickly apparent that in the case of communication, all communication relationships in the system to be analyzed must be considered before a division into parts can be taken into account that is appropriate to that system. All individuals that interact in a system must be considered in order to describe--and definitely not to prescribe--the communication structure which is present.

The above suggested procedure has been translated into the form of a computerized algorithm (Richards, 1971) using many concepts drawn from matrix analysis (Jacobson & Seashore, 1951; Weiss, 1956), graph theory (Festinger, 1949; Flament, 1963; Harary, Norman & Cartwright, 1965) as well as set theory (Wigand, 1973). The present program entitled NEGOPY is capable of the efficient analysis of the relationships within systems of up to 4,096 members.

NEGOPY has two primary goals: (1) to produce the typological description of the network under investigation (more specifically, a list of the groups within the system and a description of the rolesof all the individual members within the system), and (2) to calculate a number of statistics descriptive of several parts of the system at various levels of analysis.

With regard to the desired structural aspects to be detected from the system, the following set of definitions and criteria emerged:

I. Non-participant nodes are either not connected to the rest of the network or are only minimally connected. They include:
   1. Isolates Type One are nodes that have no links and are truly isolated within the network.
   2. Isolates Type Two are nodes which have merely one link.
   3. Isolated Dyads are nodes with a single link between themselves.
   4. Treenodes are nodes that have a single link to a participant and have some number of other isolates attached to themselves.

II. Participants are nodes that have two or more links to other participant nodes. Usually, this type of node makes up the majority of network elements and thus allows for the development of communication structure. They include:
   1. Group members are nodes with more than some percentage of their linkage with other members of the same group. This percentage is hereafter referred to as α-criterion.
   2. Liaison nodes fail to meet the α-criterion with members of any group within the network and they have the majority of interactions with members of groups, but not with members of any single group.
   3. Type other are nodes which fail to meet the α-criterion as well as the classification of the liasion and group member role.

III. For the recognition of a group the following five criteria must be met:
   1. There must be at least three members.
   2. Each must meet the α-criterion with the other members of this group.
   3. There must be some path lying entirely within the group, from each member to each other member (connectiveness criterion).
   4. There may be no single node (or arbitrarily small set of nodes) which, when removed from the group, causes the rest of the group to fail to meet any of the above criteria (the critical node criterion).
   5. There must be no single link (or subset of links) which, if cut, causes the group to fail to meet any of the above criteria (the critical link criterion).

The classification of the members of the system in terms of these specifications is achieved through two major steps. First, an approximate solution is generated through the use of a pattern-recognition algorithm to the results of an iterative operation. This operation treats each link or relationship existing between two nodes similar to a vector. Vectors have two basic attributes: direction and magnitude. The direction of each vector is understood as a nominal variable specifying to whom the link goes. The magnitude, however, is operationalized as the strength of the relationship, i.e. the extent to which the behavior of the two nodes is influenced due to this relationship. Other measures of magnitude can be operationalized as frequency, importance, intensity, etc. Under consideration of these additional characteristics of a relationship or link, a relationship is defined as:

> The mode or process in which members of a social system are connected or associated interdependently among or between each other; i.e. a partial unification of members which when considered irrespective of such a

relation, would be incapable of being conceived together (Wigand, 1974b).

The tentative solution that is generated through the above described algorithm is only an approximate description of the system's structure.

An exact solution is generated after the above specified criteria are applied to the approximate solution. Similar to the process described in the first stage, several heuristic devices are applied such that the efficiency of the algorithm can be maximized.

Once communication networks have been analyzed according to the above described criteria (see fig. 1), it is then possible to represent this network with a focal emphasis on groups (see fig. 2), on liaisons (see fig. 3), and other network roles. In addition, these detected network roles can be utilized in the form of an overlay onto the formally designed, hierarchical structure of a system, e.g., a company (Cf., fig. 1 with fig. 4). This comparison between the actual communication structure and the designed hierarchical structure may then be utilized as a rather powerful and heurisric method in redesigning a social system, in this case, a company (Cf., Monge & Lindzey, 1974; also Wigand, 1974a; Farace & Wigand, 1975; Wigand, 1976). This method, generally, relies on more precise data than most other known techniques in the many and highly popular, but frequently dubious forms of organizational development. Many of these popular techniques have not been tested for their effectiveness, there is a lack of longitudinal studies, and some of them take not into account the mulitdimensionality of social behavior.

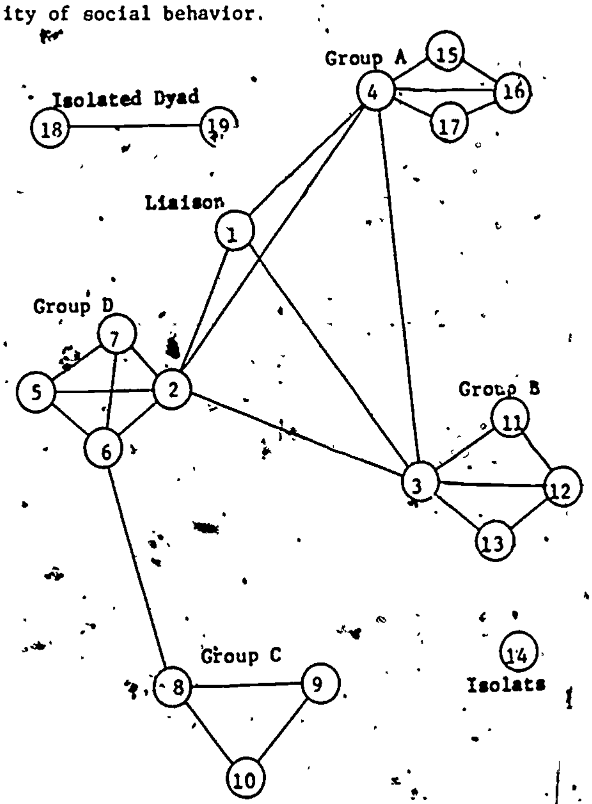


Fig. 1: Communication network among the members of System X

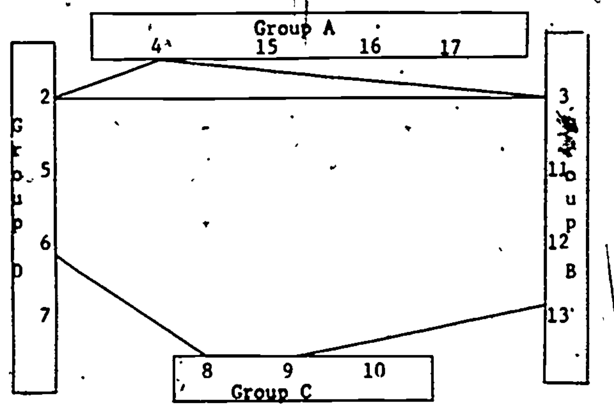


Fig. 2: Communication links between the four communication groups in the network of System X

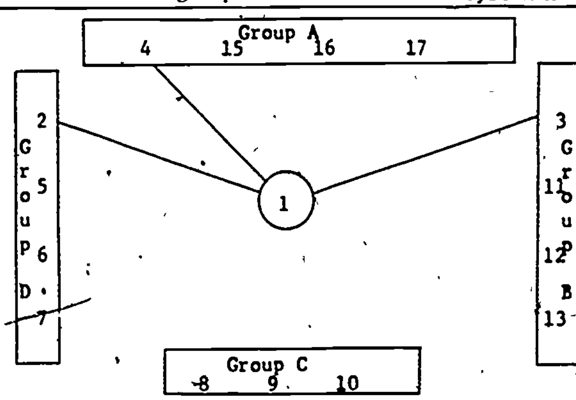


Fig. 3: Liaison linkages between the four communication groups in the network for System X

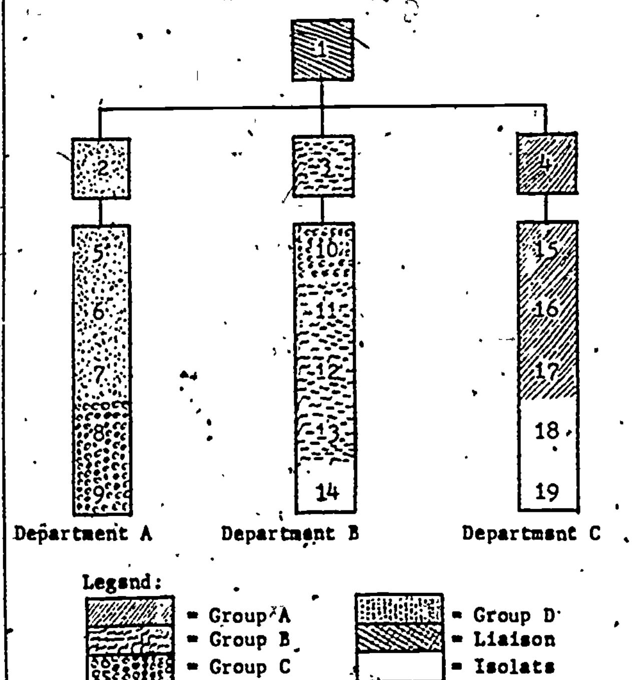


Fig. 4: The four communication groups of the network of System X within its organizational hierarchy

In addition to the classification of communication patterns into various network roles, network analysis provides a number of statistics or metrics that provide additional information about the network which is described next.

Statistical Analysis of the Network Structure

Various aspects of the detected communication structure and its breakdown into network roles can be analyzed, i.e. quantified as ratios, indices, and percentages that allow for further insight into the network. Furthermore, this quantification of network characteristics allows for greater precision when describing network roles and allows the researcher to study communication networks in relation to numerous other system dimensions (e.g., satisfaction, control, climate). There are two types of statistics or metrics that describe the network structure at two system levels: there are metrics that describe characteristics of groups and there are those that describe the characteristics of individuals. Below, a few of these are presented:

Group connectedness. A measure that indicates the number of connections or density among the members of a group is labeled connectedness. If a group has a large number of within-group links, it is said to be highly connected; if it has only a few within-group links, it is said to be loosely connected. If every node within a group would be connected with each other, then the group connectedness would be 100 percent. Obviously, this measure is dependent on the group size, since members of large groups have to communicate an unusually high amount in order to communicate with everyone else. One must, therefore, use this measure with care such that it does not loose its meaningfullness. As already suggested, this measure can be expressed as a percentage; it is also possible to derive a ratio measure through the use of graph-theoretic applications:

$$C_i = \frac{2(L)}{Nd(Nd-1)}$$

where C_i stands for connectedness of group i,
L stands for the number of actual within-group links,
Nd stands for the number of nodes existent in the network.

The magnitude of C_i may range from 0.0 to 1.0.

Individual integrativeness. This measure is conceptualized as the extent to which a focal node is linked to others; in addition, one must consider the degree to which these other nodes are connected among each other. A particular node's integrativeness is thus determined by examining the links that connect this node to other nodes. Next, one specifies the links that exist among these other nodes. If they are all linked to each other, one may state that the integrativeness of the focal node is maximally high. If they happen to be isolated from each other and their only connection is through this focal node, then, it may be stated that this focal node has a low integrativeness. Derived from graph-theoretic measures, individual integrativeness is expressed in the following formula:

$$I_i = \frac{2(Lo)}{l_i(l_i-1)}$$

where, I_i stands for the integrativeness of individual i,
L_o stands for the number of actual within-group links among those other individuals with which i is connected (excluding i's linkages directly connecting with those other individuals),
l_i stands for the number of actual linkages to and from individual i.

Communication flexibility index. In terms of flexibility, one easily will conceive that the most restrictive network structure is the cyclic network. Consequently, it follows that the highly decentralized network is the least restrictive structure with respect to flexibility. These two extremes can then be designated as being either 1-flexible for the decentralized network or 0-flexible for the cyclical network.

A communication network (N) with n nodes (nd_n) is defined as having a minimum of links (L_{min}) when

$$L_{min} = nd, \text{ where } nd>1,$$

and a maximum of links (L_{max}) when

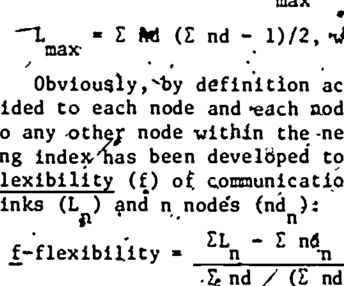
$$L_{max} = \Sigma\, nd\,(\Sigma\, nd - 1)/2, \text{ where } nd>1.$$

Obviously, by definition access must be provided to each node and each node must be accessable to any other node within the network. The following index has been developed to show the degree of flexibility (f) of communication networks with n links (L_n) and n nodes (nd_n):

$$f\text{-flexibility} = \frac{\Sigma L_n - \Sigma\, nd_n}{\Sigma\, nd_n\,(\Sigma\, nd_n - 2)}$$

where, ΣL_n represents the sum of all links*) (Bi-directionality counts as two links), and where nd_n represents the sum of all nodes within the network.

The above formula for flexibility should meet the initial considerations of determining the cyclic network as 0-flexible, and determining the decentralized network as 1-flexible. The example presented in Fig. 5 shall explicate the above formula for the network structure A.



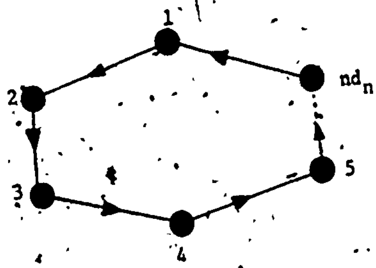
$$f = \frac{L_n - nd_n}{nd_n\,(nd_n - 2)} = \frac{10-5}{5(5-2)} = \frac{5}{15}$$

= .33-flexible with five nodes

Fig. 5: An application of the flexibility index

* The term link (L) is defined here as being merely unidirectional, thus only existing in the direction of nd_1 to nd_2 or nd_2 to nd_1, but not both or constituting a reciprocal relationship. If a reciprocal relationship exists between two nodes, the value for L is 2.

It is obvious that when calculating the flexibility-index, f, the difficulty of computing the value for L by merely examining the network in graph format increases as Σ nd becomes large. The value for L, however, can easily be specified by developing the corresponding n x n adjacency matrix, M_N, for the network (see fig. 6).



Network N

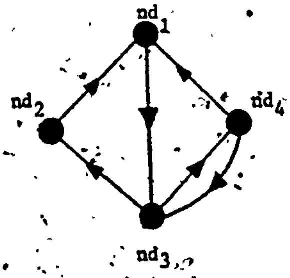
$$M_N = \begin{bmatrix} 0 & 1 & 0 & 0 & \dots & 0 \\ 0 & 0 & 1 & 0 & \dots & 0 \\ 0 & 0 & 0 & 1 & \dots & 0 \\ & & \vdots & & & \\ 1 & 0 & 0 & 0 & \dots & 0 \end{bmatrix}$$

Adjacency matrix M_N of network N

Fig. 6: A network and its adjacency matrix

It should be noted that the adjacency matrix can only then be developed as long as Σnd is reasonably small. If Σnd is not too large, subsets (groups, etc.) of the network can be analyzed for their flexibility. Each entry or value, m_{Nij}, in matrix M_N of fig. 6 is defined as 1 if a unidirectional link is present from nd_i to nd_j, whereas nd_i and $nd_j \in N$. Particularly with regard to the flexibility index, it should be pointed out that no node is represented in the adjacency matrix that communicates with itself. Therefore, the matrix diagonal consists of zero (0) entries only.

Communication accessibility index. A communication network is defined as being a-accessible where a indicates the minimum number of referrals necessary to enable complete accessibility, i.e. every node has access to every other node. The index for accessibility is developed from the graph A and the adjacency matrix M_A in figure 7.



$$M_A = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 \end{bmatrix}$$

M_A is the adjacency matrix of graph A

Graph A

Fig. 7: Graph A with its adjacency matrix M_A, from which the notion of accessibility is developed

Matrix M_A can then be squared (M_A^2) and cubed (M_A^3):

$$M_A^2 = \begin{bmatrix} 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 2 & 0 & 1 & 0 \\ 0 & 1 & 1 & 1 \end{bmatrix}$$

With regard to accessibility, the value $(m_{A31})^2 = 2$ indicates that there are 2 sequences of length 2 in graph A from nd_3 to nd_1, namely, nd_3, nd_2, nd_1, and nd_3, nd_4, nd_1.

$$M_A^3 = \begin{bmatrix} 2 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 \\ 0 & 1 & 2 & 1 \\ 2 & 1 & 1 & 1 \end{bmatrix}$$

$$\vdots$$

$$M_A^n$$

In the case of the cubed matrix M_A, i.e. M_A^3, the entry $(m_{A13})^3 = 1$ suggests that there is 1 sequence of length 3 in graph A from nd_1 to nd_3, namely nd_1, nd_3, nd_4, nd_3.

Generally, accessibility is, therefore, determined by the entry $(m_{ij})^n$ which gives the number of mutual choices for access involving person nd_i:

$$a\text{-accessible}_{min} = \sum_{j=1}^{n} M_j$$

where, M_j has elements $(m_{ij})^n$ from the adjacency matrix M and $(m_{ij})^n$ specifies the number of cycles or referrals in M from nd_i to nd_j.

Other measures. Various other measures with regard to distance, dominance, centrality, etc. are available, but are not presented here due to space limitations.

A set of dispersion metrics has been developed that demonstrates the extent to which units vary in the degree to which they show some property: the variance in the relative frequencies or strength of the links to a given node, the variance in rows and columns means for a distance matrix, the variance in the number of links each node has, the variance in the entries of a given row or column of a distance matrix for a subset of the network, etc. Among the dispersion metrics also included are information-theoretic measures since they refer to the extent to which relative frequencies of occurrence vary from event to event within the set of all possible events (e.g., uncertainty measures, etc.).

Much of the above discussed measures can be readily represented by the analyst in 'communicator's profiles' for each individual network member. Typically, such a 'communicator's profile' gives information about the individual's network type, his network role, membership in a specific group, information about his links (e.g., total number, within-group, to or from group bridges and liaisons, reciprocated and unreciprocated), the percentage of individual connectedness, his percentage contribution to group liaison linkage, as well as his percentage contribution to between-group linkage, and others.

Conclusion

This paper has described a way in which the communication behavior of social systems can be represented through the use of the network analysis technique. Communication networks are generated by the analysis and subsequent representation of detected patterns of communication contacts among individuals within a social system. Several network roles (group member, liaison, isolate, and others) have been identified which can be further described through various statistical measures. It was pointed out that systems analysts typically encounter difficulties in assessing system parts such that this assessment is relevant to the overall, integrated system. Network analysis was designed to overcome in part some of these inadequacies. In addition, this technique emphasizes a systemic, specific and precise set of criteria that are applicable to all types of social systems.

Collins and Raven (1969) point out that an unfortunate state of affairs is prevalent throughout the entire network literature, "It is almost impossible to make a simple generalization about any variable without finding at least one study to contradict the generalization (p. 147)." It is the contention of this author as well as the group of individuals engaged in the development of the network analysis technique that the methods described in this paper may considerably improve ways for the description and analysis of as well as eventually lead toward the explanation and prediction of the communication behavior existent in social systems.

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APPENDIX

NETWORK ANALYSIS SAMPLE DATA GATHERING INSTRUMENT

____
Your ID Number

Below are the names of persons in this organization. First, please circle your own name and then record the number next to your name in the blank space provide for "Your ID Number" at the top of this page. Using the Communication Frequency Scale below, indicate how often you communicate with each person face-to-face. Then, evaluate this communication with regard to the importance of that communication frequency by using the Communication Importance Scale below. Lastly, repeat this procedure for communication by telephone. Then continue with the next person, etc.

Communication Frequency Scale:

6 - Several times a day or more
5 - Once or twice a day
4 - Several times a week
3 - Once a week
2 - Several times a month
1 - Once a month

Communication Importance Scale:

0 1 2 3 4 5 6 7 8 9 10
low high
IMPORTANCE

How often do you communicate with these persons?
How important do you judge this communication?

	Face-to-Face		By Phone?	
	Frequency	Importance	Freq.	Imp.
001 D. Adams				
002 J. Black				
003 B. Calder				
004 F. Dawsey				
005 P. Erickson				
006 S. Fulton				
etc. etc.				

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COMPUTER ANALYSIS OF SCHOOL-COMMUNITY PARTNERSHIP BUDGET QUESTIONNAIRE

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ABSTRACT: Questionnaires printed in both English and Spanish were mailed to almost 37,000 parents, one per family, prior to January 1, 1976. A total of 5,979 (16.5%) responded; 109 were answered in Spanish.

A statistical summary is included as part of the paper. This large district (K-12, enrollment 63,000) survey required cooperation between parents, research personnel, business manager, central staff, and extensive data processing support.

The attached report describes parent priorities ranked from one to ten and from a request to data processing for list of mailing labels, one per family, through analysis of priority printouts.

Results were tabulated for each of the three areas, each of the three school levels and the total district. A general summary follows:

A. Parents' priorities if additional funds become available. . .

1. "More reading specialists and helping teachers in basic curriculum areas to give teachers assistance in meeting specific student needs"
2. "Expanded vocational and career education"
3. Priority for all parents except in Area A Elementary Schools
"Reinstatement of behind-the-wheel driver's training"
. Priority for parents of Area A Elementary Schools only
"Increased offerings in multicultural bilingual education" (all other parents ranked this as priority 6 to 10)
4. "Full freshman curriculum, 6 courses at student option instead of 5"

B. Parents' priorities for reducing expenditures

1. "More sharing of personnel and facilities with other community agencies"
2. "Reducing expenditures for inservice training and released time for staff"
3. "Closing schools with low enrollment"
4. "Concentrating advanced high school electives at designated schools"

C. Parents' opinions of class size

27% selected "remain the same"
26% selected "be reduced by not more than 1 student"
44% selected "class size increased by not more than 1 student"
3% did not respond

D. Parents favor and support

34% Legislative Changes
8% Budget Override
36% Both
18% Neither
4% No Response

Parent Results From Question E (required an open-ended response)

If you were a member of the School Board and had the opportunity to decide what the District Budget Priorities would be, what action would you take?

The 3,339 questionnaires with comments contained many divergent suggestions and views. The following direct quotes present a few of the varied responses.

"Save by consolidation. I would be interested in an economic analysis of the cost of providing small participation, high cost activities (drama, photography and many others) per pupil. I would be in favor of bussing students to one facility for some of these."

"It would be well if education became one of the priorities. Discipline for teachers who take days off for business other than school business. Classes should prepare students for their future. Eliminate waste -- utilize teacher's time. Give the students our monies worth. Less expensive, functional school buildings. Monitor teachers and classrooms."

"Get rid of tenure for teachers as there are far too many that are teaching that lack interest in both children and teaching. Poor teachers should not be allowed to remain. More efficiency at the Administrative level. (District One personnel could use a good 'housecleaning')."

"Get education back to the basics and get rid of a lot of middle-level desk men, i.e., administrators, assistants, deans, coordinators, etc."

"More reading specialists. More offerings in multicultural/bilingual education."

"Doing away with or reducing the number of assistant principals, secretarial and other office duties except the absolute necessities. Restoring behind-the-wheel Driver's Ed. which is most important. Keeping all J.V. and Varsity sports. Expanding vocational and career guidance and education for those not contemplating college."

"Have parents that can help give $1.00 or $2.00 more through their child to help with extra supplies in classroom. I don't want my taxes to go up but would not mind sending more money for supplies, books, etc."

"1. Resolve the busing issue.

2. Emphasize the 4 basics and eliminate nice-to-have courses and electives which drain the budget.

3. Follow up all student progress beyond high school and determine who in the schools is successful and why.

4. Develop some positive coordination between elementary, junior high, and high-school curricula -- this is not adequate at present."

"Stupid question!! How does someone who is not a member of the School Board know what alternatives the Board has from which to decide or choose priorities???"

"Este cuestionario esta escrito con palabras que son muy dificiles para comprender."

"Use buildings 12 months of the year, 7 days a week, 16 hours a day.

__Reduce amount of grounds maintenance. Switch to native plants -- do away with grass -- use sand, gravel, cactus.

__Involve children in maintenance tasks, with supervision.

__Involve parents in teacher assistance in the classroom. Create an attractive brochure explaining how parents can help.

__Where additional funds are needed for a specific program -- request donations from parents to prepay program not funded."

"Driver education should be fully restored with enough support and facilities/equipment so that each eligible student can learn to drive. . . .A working system in North Carolina taxes each auto/vehicle license purchase of over $5.00 by $1.00 for use of the driver education program. The one dollar per license sale supports the entire program and gives each student the opportunity to learn to drive SAFELY!"

1. The questionnaire was designed with input from school councils by the Budget Subcommittee of our District School-Community Partnership Council. This process occurred over a two month time period. A final draft of the instrument was approved by the District One School Board and the District Council.

2. Mailing labels were requested from data processing (zip code/last name/address), one per family.

3. Keypunch format was added to questionnaire.

4. Questionnaire printed in two languages was bulk mailed by January 1, 1976.

5. Questionnaires were returned to local schools or mailed to our district office.

6. Staff of Research cleaned questionnaires prior to keypunching, eliminated bad cases and coded open-ended responses (would not do this last operation again). We sorted into schools prior to submission to data processing.

7. Data processing keypunched and cards were run on TPS 03 Research Department Fortran Program which creates frequency and percent tallies.

8. Research staff weighted the responses and determined priorities for questions A and B.

9. Research staff prepared final charted data reports and selected comments to reflect views and suggestions of responding parents.

10. Budget Committee looked at the results and Chairman Engel prepared the cover letter (see recommendations).

11. Final report was shared with the School Board just prior to being released to the media.

Our District One Board voiced appreciation to the parent group for their efforts and plan to use the accumulated data to aid them in future district budget decision making.

COMPUTERS, SOCIETY, AND SCHOOLS

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ABSTRACT: Providing background for the conference session, this paper describes some of the impacts and issues of the "computer revolution" as it affects the individual and society. During the session, the authors will highlight some of the points of the paper through visuals and present ways in which the schools might be involved in the effort to prepare future generations for the "Man-Computer Age".

The beginning of the end of the industrial revolution occurred in the middle of the 1950s when two events happened: the majority of the American work force shifted from manufacturing goods to delivering services, and the first commercial computer became available.[1] The first event made this country the first "post-industrial" nation; the second allowed the 20th century "steam engine" to become more than just an instrument of science, but a tool of the booming service industry.

The industrial revolution freed the human race from the land, creating in two centuries a largely artificial environment. The computer revolution promises to free the human mind; where that could lead in two centuries staggers the imagination. But there is no turning back.

The availability and efficient capabilities of the computer have made it a highly attractive tool in coping with the "information explosion". Amitai Etzioni tells us that the Organization for Economic Cooperation and Development forecast that "in 1985-87, 6 or 7 times the present volume of new information will be produced." But by 1987 "the degree of automation of information will approach a hundred times that of today." Thus machines will do even more of the work of coping with the avalanche of information.[2]

The computer is also on its way toward becoming a household appliance--an attendant infinitely adjustable to our needs, but one to which we will also have to adapt.[3] When we pass the threshold to where computers are a direct tool of a major segment of citizens in their daily lives we will be in a new era in the annals of humankind: the Man-Computer Age. And there is no turning back.

A look at the present portends a "computer-world". Computers are no longer a novelty or a tool restricted to use by a few highly trained professionals. The influence of computer technology is evidenced in many dimensions of society from the spectacular feats of facilitating space exploration to the mundane, practical tasks of processing checks and producing mailing labels.

Applications of computers in society exhibit varying roles in terms of how they impact upon the typical citizen. Some recognition of the role of computers results from the manner in which computers directly touch the daily lives of the individual or family. Other more direct applications of computer technology form the underlying structure for many systems and functions having wide-reaching, global effects. Not unaffected by the continuing computer revolution, the average person forms some impressions of the nature of computers and their pervasiveness on society while the larger, philosophical issues raised by the computer revolution may never reach his conscious level of awareness.

Probably the most obvious and ubiquitous evidence of the application of computers is in automation of the "paper shuffling" and related tasks associated with daily transactions between individuals and organizations or services.

An individual's paycheck is now typically prepared by computer. It is generated by a computer recordkeeping and accounting system which handles multiple facets of the firm's internal administrative needs as well as external requirements for records and reports.[5] Computer processing of an individual's income tax returns interfaces with another product of the computerized system, the W-2 form.

As money (or its representations) flow through the economic system, further applications of computers are encountered. Banking has computerized most aspects of the processing of checks and maintenance of accounts, facilitating recent moves into such areas as automatic bill payment and installation of electronic tellers. The individual also finds a computerized basis for credit card transactions and account billings, magazine subscriptions, and accounts with book clubs.

The traveler may make inquiries and reservations through a computerized system which links many airline reservation desks together. Similar transactions can be made via computer for lodging accommodations or for rental cars.

Transactions for the local commuter may also be computerized. The Bay Area Rapid Transit System in San Francisco is essentially computer controlled. Fares are based on the exact number of miles each passenger travels and are computed with the use of a magnetically coded card as the passenger gets on and off the system.[6]

A more recent application has moved the computer into the supermarket where consumer purchases may be checked out through automatic reading of product/price codes which generates a printed bill for the customer and provides current information for inventory control and sales trends.[7] An "unmanned" supermarket has recently become operational in Japan and serves as a prototype of an "automated merchandising" system.[8]

The prevalence and feasible coordination of such computerized systems suggest the inevitability of a system in which a uniform payment principle can be applied in purchase of a variety of goods and services. This "electronic funds transfer movement"[9] would bring us from our "cashless" society of plastic (credit cards) and paper (personal checks) transactions that ultimately reduce our bank balance, to a "checkless" society where the use of a computer sensitizing card will allow direct access to bank accounts allowing financial transfers to occur in a computer memory at the time of sale.

Besides their significant role in the daily transactions of the life of the consumer, computers are responsible for the coordination and control of numerous functions and processes in many sectors of society. Some of these applications operate "behind-the-scenes" and are perhaps not as obvious to the casual observer.

Sophisticated computer systems are in operation for both ground and air traffic control. The flow of surface traffic in many major cities is facilitated by computer regulation. Monitoring of air traffic is also handled with computer assistance.

The National Weather Service now prepares and distributes its weather forecasts through a network of minicomputers;[10] and computerized typesetting and editing have revolutionized the printing/publishing field.

The wide use of computers in industry includes not only the automation of production processes, but also applications in many operations relating to the design, manufacture, and distribution of products and their components. Computer analysis of needs and utilization of electric power enabled one factory to realize an energy and cost saving by reducing the consumption of electricity.[11]

In the field of health care, computers not only serve as a tool for recordkeeping and administration, but have increasing roles in the monitoring and diagnosis of patients and in control and analysis of laboratory tests.[12]

Computers handle the unwieldy volume of data necessary to maintain numerous programs and the underlying tax structure in the governmental sphere. The executive branch of government alone has almost 8,000 computers staffed by over 100,000 employees.[13] Computers audit tax returns[14] and assist in the analysis and design of municipal tax assessment systems.[15] Analysis of public opinion polls and processing of electoral returns via computer provide input for the political process.[16] The legal system has also recently felt the impact of computers through such uses as generation of evidence for litigation[17] and more rapid production of trial transcripts.[18]

Applications in science and technology are numerous, but are perhaps overshadowed by developments in the space program. Even those with a casual interest are aware that space explorations would not have been possible without computers. The United States landed astronauts on the moon before the Soviet Union primarily because of superior computers for control and navigation.[19]

The capability of computers to model and simulate aspects of the environment allows the study of probable effects of certain actions and provides insights into complex processes or conditions such as pollution control or river flow and water supply. Computers provide a model for the management of Wisconsin's forest resources[20] and assist in genetic analysis for crossbreeding of livestock.[21]

The educational system has also been an application area for computer technology. Computers are used to assist in both the generation and dissemination of knowledge through research and instruction, as well as in the variety of administrative functions and services.

There is hardly an area of society which has not felt some impact of computers. Even society's sports and recreational activities have been affected by computers. The racing yacht, Courageous, which won the 1974 America Cup carried a minicomputer on board for navigational and tactical calculations.[22] Professional football leagues utilize computers to aid in the process of drafting players, while computerized recordkeeping and communication brought new dimensions to the activities of the Olympics since 1972.[23]

Twenty years ago if one looked in the Readers' Guide to Periodical Literature under "computing machines" one would be directed to "calculating machines," which would be the only major heading referring to "computers". Three subheadings would be found there, two of which were uses of these machines: meteorological and military.

Ten years ago if one looked in the then current volume of the Readers' Guide, five major headings which begin with "computer" would be found with 36 subheadings--25 of which were application areas.

Five years ago if one looked in the current edition of the same publication, 24 major headings concerning computers would be found with 62 subheadings--48 of which were application areas.

The growth has been exponential.

When ENIAC was first built, some experts predicted that 100 similar machines would be sufficient to fill the needs of the country. Now the United States has 134,000 computers and another 100,000 or so are spread around the rest of the world.[24] In the U.S. today, ten percent of all business expenditures on new plant and equipment is spent on computers and associated systems.[25]

Since the introduction of commercial computers, the cost of calculation has fallen more than a hundred-fold, calculation speed has increased by a factor of 10,000 and space requirements have shrunk to about one-eight-hundredth of their original size.[26] Improvement will inevitably continue. Already a fifty pound, $10,000 computer is available from IBM.

Today, general purpose computer installations in the U.S. have a value of $40.8 billion. Arthur D. Little, Inc. predicted that by 1980 it will be around $60 billion in constant dollars.

THE FUTURE

If we define the power of a computer as the product of its basic speed and its fast memory capacity, then Herman Kahn predicts that during the decade of the seventies alone, this power should increase, in the largest and most advanced computers, by a factor of 10,000 or so. As a result Kahn said that many of the most extravagant technical remarks seem likely to be held to be rather conservative from the vantage point of 1980. He continued: By the end of the seventies the world is likely to look quite different to younger people. For example, it is almost certain that computer-assisted instruction and computerized retrieval systems for information will begin to be ubiquitous in schools and other institutions frequented by the young, as least in more developed nations. For many children the computer will, literally, play a role less than, but close to, that of parent and teacher.[27]

Donald Michael reported what seems obvious: that the long-range stability of the social system depends on a population of young people properly educated to enter the adult world of tasks and attitudes. Once, the pace of change was slow enough to permit a comfortable margin of compatibility between the adult world and the one children were trained to expect. Today, in the age of computers, we are not sure of the appropriate kind of education for the current generation--certainly not a linear projection of what we were taught. If we do not look at the long-range needs of members of our society and appropriately modify our educatinal systems, we will have a population that is more and more out of touch with social realities and occupational needs.[28]

Gruenberger reiterated the fact that only now, in the 1970s, are computers feasible in both size and cost for their permeation of society. He said: "For some people, computers have been around for all their lives. For everyone, computers will be around from now on. We must learn to live with them."[29]

According to a survey of experts which was conducted by the Institute of Electrical and Electronic Engineers[30] by 1981 computers will be used as the basis of medical diagnosis and traffic control, able to receive information through optical character recognition, and composed of ultra-small integrated circuits fabricated using electron beams and X-ray lithography. Over the following three years, computer terminals will become common in general office use, which will also benefit from electronic data files and communications network. By 1987 Josephson junctions are expected to revolutionize the central processing units of large computers while miniature computers may be used to control artificial human organs.

Even now, computer monitoring--telemetering information from tiny sensors and transmitters embedded in the human body--keeps recalcitrant hearts beating steadily. In a few years they may transmit information about subtle internal states through a computer to a physician, and may even be attached to parolees or social deviates.

James Albus, who worked in computer automation at the National Bureau of Standards, said that "Within two decades it may be practical for computer-controlled factories and robots to produce virtually unlimited quantities of manufactured goods, and to even reproduce themselves at continuously decreasing costs." Already, introduction of numerically controlled machine tools to existing industries can result in productivity increases of up to 400 percent.[31]

Possibly the greatest impact on daily life may come from combining computers with sophisticated means of communication to form data networks. Just as the growth of industry drew great masses of people together to form overcrowded cities, networks and computer-coordinated transportation systems may free them again to seek alternate lifestyles in communities of their choosing. By creating "computer cities" people will soon be able to enjoy the benefits of urban jobs, services and culture, wherever they live.[32]

In the Man-Computer Age the computer will be as ubiquitous as the typewriter, the desk calculator or the telephone. Information processing in the Man-Computer Age will be as easy to use as the telephone. A small-sized terminal will be available for individual use at a reasonable cost for the function it performs, and capable of performing mental tasks on a real-time basis with the availability of all the necessary data.[33]

Kahn sees that by 1980 the interaction of man with machine would be carried to the point where the two will be able to function in a working partnership in many creative enterprises. By that date he said it is likely to be at least in the homes of the richer families, as a convenient central method of regulating temperature, humidity, various cooking devices, home accounting, access to mass media and libraries, and so on. Computers may even have the capability to begin to play surrogate mother or at least surrogate baby-sitter and playmate as well as tutor and/or teacher. Such household computers might well have access to a very large variety of entertainments, and a number of alarm-type circuits to inform the parents or neighbors when they should look in themselves on what the youngsters are doing.[34]

IMPLICATIONS

The present state of computers in society and their projected role for the future have not gone unnoticed by those who reflect on the implications for life in such a world. There are four major issues which have been repeatedly raised about the impact of computers on society: automation, power, individuality and privacy.[35]

Automation

The industrial revolution centered on the supplementation and ultimate replacement of the muscles of man and animal by mechanical methods. The Computer Revolution went beyond this to the supplementation and replacement of some aspects of the mind of man by electronic methods. Both changes have had widespread implications on the world of work: if not replacing people, displacing them, from burdensome, tedious and repetitive tasks--"freeing" them for more challenging activities, while productivity and cost are optimized. A corresponding increase in the amount of leisure time available to working people has been due to the decreased need for human involvement.

Norbert Wiener tells us that since machines of the future are going to take away a lot more jobs from humans, we can no longer value a person by the jobs he or she does. We have got to value him as a person.[36]

Power

Data is power, and computers mean data. The centralized accumulation of data permits the concentration of enormous power in the hands of those with access to the computer. The very existence of sophisticated computers leads to a power gap between those trained to use and understand them, and those who are not.

In another sense of power, computers seem sometimes to dictate how, when and what we do. Systems failures, for example, can create chaos and catastrophe--we have rather recent examples in the area of electrical power systems, and we have the vivid threat of a possible failure of a ballistic missile system failure.

Individuality

This is a value that has been cherished

in the United States since its beginning. Being involved in a society that is wired to computers means that our individuality is altered; at times our essence is pared to a bare number.

Computers are especially useful for dealing with social situations that pertain to people in mass, such as traffic control, fiscal transactions, consumer goods; allocations of resources, etc. They are so useful in these areas that they undoubtedly will help to seduce planners into inventing a society with goals that can be dealt with in the mass rather than in terms of the individual.[37]

The direct societal effects of any pervasive new technology mean little compared to the more subtle and ultimately much more important side effects. In that sense, we have not yet felt the societal impact of the computer.

In the same way that perhaps the greater impact of the atomic bomb was felt by those people who lived since Hiroshima and Nagasaki and who are aware of what happened and what might happen, the potentially tragic impact on society that may ensue from the use of computer systems will likely come as side effects and not direct effects. In the case of the atomic bomb and the computer, there is a psychological impact on individuals in which forces which are anonymous formulate the large questions of the day and circumscribe the range of possible answers.[38]

Consider too that computer-based knowledge systems become essentially unmodifiable except in that they can grow, and since they induce dependence and cannot, after a certain threshold is crossed, be abandoned, there is the expectation that they will be passed from one generation to another, always growing. Weizenbaum concluded:

> Man too passes knowledge from one generation to another. But because man is mortal, his transmission of knowledge over the generations is at once a process of filtering and accrual. Man doesn't merely pass knowledge, he rather regenerates it continuously. Much as we may mourn the crumbling of ancient civilizations, we know nevertheless that the glory of man resides as much in the evolution of his cultures as in that of his brain. The unwise use of ever larger and ever more complex computer systems may well bring this process to a halt. It could well replace the ebb and flow of culture with a world without values, a world in which what counts for a fact has long ago been determined and forever fixed.[39]

Herman Kahn made some strong statements concerning the potential pervasiveness of the computer--strong statements, but ones reflecting careful consideration:

> As far as I know, despite many popular and sometimes expert statements to the contrary, nobody has demonstrated any intrinsic limits to what the computer can eventually do in simulating or surpassing human capabilities. There is a clear capability for mimicking the appearance and characteristics not only of such human activities as analysis, calculation, and playing games, but of activities which have a large aesthetic, emotional, or seemingly intuitive content...It is my personal conjecture, and one which personally always depresses me as well, that by the end of the century, if not by 1980, the experts will have concluded that the computer can transcend human beings in every practical aspect. I do not know what this means in terms of philosophy, religion...and even the democratic way of life...[40]

Time after time science has led us to insights that, at least when viewed superficially, diminish man: Copernicus removed man from the center of the universe, Darwin removed him from his place separate from the animals, and Freud showed man's rationality to be an illusion. Man's view of himself is continually being narrowed, but at the same time perhaps made more accurate.

When asked if man is changing his environment beyond his capacity to adjust to it, Norbert Wiener said: "That is the $64 question. He's certainly changing it greatly, and if he is doing it beyond his capacity, we'll know soon enough. Or we won't know--we won't be here."[41] He also said that the use of computers is irrevocable. It is not merely the fact that the computers are being used. It is the fact that they stand ready to be used, which is the real difficulty. In other words, the reason we cannot go back is that we can never destroy the possibility of computers being used.

The most important aspect of the late seventies is less likely to be the actual technological developments of the next decade than an increased understanding of what the emergence of the coming technology, the post-industrial culture, and the computer age is likely to mean.

Many of the people who will first live in this kind of world are alive today.

The predicted hundred-fold increase in the automation of information by 1987 brings some of the issues closer to us. In 1987, today's first grade students will be high school seniors. Will they be prepared to face that world?

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CONVINCING TEACHERS THAT THEY CAN COMPUTE

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Recognizing the importance of developing widespread computer literacy in our society, it is apparent that qualified instructors of computing are needed in large numbers at all educational levels. The paper (1) identifies an available labor source, (2) discusses a perspective toward computing which treats computing as a fundamental human activity, and (3) presents an approach to the teaching of basic computing concepts which is being used in the computing literacy course designed for educators currently offered at Teachers College, Columbia University. Finally, the author argues that the major role of computing in education ultimately may be its contribution to the development of general problem defining and solving skills.

Just as Moliere's bourgeois gentleman was delighted to learn that he had been talking prose all of his life, so it should be a pleasure for people to learn that they have been computing all along.

Everyone Agrees That Computers Are Important

Computers have become such an integral part of the workings of our society that no one seriously disputes their importance. In fact, most people would agree that they ought to know something about computers even if the great majority of the public continues to be ignorant of them. Nevertheless, the necessity for a computer literate society has been convincingly argued on many occasions, and can be assumed to be a worthy social goal.

Perhaps the most commonly heard recommendation as to the target group and setting for bringing about computer awareness has been the junior or senior high school student in a standard schooling situation. Although the validity of this recommendation can be argued, there is no arguing the need for qualified teachers if general computer literacy is to be realized. Currently, the responsibility for delivering computer instruction at the secondary school level usually falls on a member of the mathematics or science department, since the knowledge of a more quantitative discipline is thought to better equip one to deal with computers. Thus, the poor teacher spends a summer scrambling about trying to bone up on computers. Alternately, a computer professional is recruited who may have little or no teaching background. This lack of qualified instructors is not surprising in view of the fact that only two states currently recognize computer sciences as a certifiable subject matter area at the secondary school level. Understandably, there has been relatively little incentive for schools of education to prepare teachers for this area. The consequences are predictable. To put it bluntly, today's teachers are as a group, embarrassingly computer naive.

An Untapped Labor Source Is Available

So what do we do about it? One answer is to simply wait. A new generation of teachers who have grown up with computers and take them for granted will surely replace the current generation.

But if formal schooling is to be the primary means for transmitting computing awareness and skills, can we afford to rely on this process of attrition? Without suggesting an answer to this question, it is enough to point out that more active opportunities currently exist. Since many school systems throughout the country have been experiencing either declining pupil enrollment or severe financial pressures requiring personnel cutbacks and teacher training institutions continue to produce graduates in great numbers, an oversupply of classroom teachers has resulted. This is leading many teachers to seek new career patterns within education which will place them in a position where their services are more likely to be in demand. For these people computing may well become an increasingly attractive alternative. As evidence of the new demand for computing skills in education, a recent study sponsored by the National Science Foundation has projected that every public secondary school in the United States will have a computer or computer capability by 1984.

Of course, we would like to have teachers driven to computing by other than strictly economic necessity. There is no disputing that the field possesses substantial intrinsic interest to challenge a large number of those who allow themselves to become involved. This, along with the aforementioned social importance of computing mentioned earlier, add further attractiveness to the computing field.

Teachers Are Computer-Shy

If computers are so attractive and important then why aren't more teachers striving to learn about them? The answer is simple: computers tend to intimidate people who know nothing about them. More specifically, people generally feel that they do not have the background or aptitude to master what they perceive to be a highly technical and specialized area, and therefore do not subject themselves to an experience that they feel is likely to lead to failure. This feeling of inaccessibility to computer understanding has been perpetuated by the popular press and those who wish to maintain an elitist view of the field. Of course, such misgivings are largely unfounded. There is no reason why the vast majority of teachers cannot grasp basic computer concepts with ease. They simply need to be convinced.

What One College Is Doing

The remainder of this paper discusses an approach to introducing basic computer concepts which is currently being employed at Teachers College, Columbia University in its computing literacy course. The course, designed primarily as a first course in computing for a wide cross section of practicing educators, is intended to overcome prevalent fears concerning computers while exposing students to the great richness of applications and broad implications of computers in our world. Besides providing a basic overview for those who wish only a general orientation to computing, the course also serves as an entry to the College's master's level Program in Computing and Education. This new program is specifically tailored for individuals who wish to make effective use of computers in educational settings. In particular, one branch of the program is concerned with preparing instructors to teach computer programming.

A Broadbased Approach to Computer Literacy

One of the common problems with much introductory computer instruction is that it begins with the computer itself. That is, someone tries to get students to understand what a computer does by describing what a computer is and how it operates. This is a seemingly reasonable approach. But to the hesitant neophyte, who feels a bit uneasy when confronted with a hand calculator, experience has shown that the mere mention of such terms as arithmetic/logic unit, object code and operating system often results in confusion and frustration. That is not to say that these and similar concepts are not fundamental to computer literacy; the difficulty is that such structural and technical aspects of the computer are presented outside the context of the student's everyday life. And when students can find no suitable context for their educational experiences, they feel that their studies lack relevance.

Making Computers Relevant

When attempting to convince students who have no plans to enter the computer field that computers are nevertheless important to know about, the arguments generally run something like this: computers are important because they compute gas and phone bills, process census data, predict who will win elections, control the operation of factories, make moon landings possible, and when improperly used may create many personal difficulties and inconveniences. In other words, computers are relevant to everyone due to their increasingly pervasive (sometimes insidious) impact on our lives.

But this is an unnecessarily passive view and does not set a tone that encourages students to participate in computing activities. Instead, a more positive approach is to view computing as a fundamental human activity in which all people are active participants. According to this general perspective, computing means the systematic analysis, planning, performing and evaluating of well specified tasks. This procedural or algorithmic interpretation of computing makes computing common to everyone. We all regularly perform routine tasks, such as tying a knot or driving a car, without giving the procedures and subprocedures by which these tasks are accomplished any conscious consideration. Nevertheless, the performance of these tasks did require formulation and solution at some point. We need only witness a child struggling to master a task which will later become routine to be convinced of this. Thus, it is this universal procedural view of computing that gives computing its overriding relevance.

Computing Literacy Versus Computer Literacy

The universal computing perspective just described places computing at a level accessible to everyone. By adopting this attitude, students are introduced to computing in a manner that emphasizes their participation while deferring any discussion of the computer itself until it has been properly motivated. As a result, students should gain confidence in their ability to master computing skills once they realize that they have been skillfully computing nearly all their lives.

When it does become appropriate to introduce computing via the computer, it can be simply viewed, at least initially, as nothing more than a rather special instance of the general computing concepts that already has been developed. A computer system, then, becomes a mechanical device for carrying out computing activities while the specific system components can be explained in terms of their functional contribution to these activities. Once students become more comfortable with basic computing concepts, it will be much easier to demonstrate how these concepts can be combined with the powerful information processing capabilities of the modern computer system to create modes of computing that not only extend but are qualitatively different from procedures commonly performed by humans.

An Approach to Teaching Basic Computing Concepts

The distinction between computing in general and computing via the computer has been particularly useful in designing the literacy course currently offered at Teachers College. A few words about the student body might be illuminating at this point.

Teachers College is a graduate school of education. The great majority of its students are or have been practicing educators and are thirty or older. This means that the idea of a computer was not commonplace during their formative years, and is still shrouded in mystery for many of them. Encouragingly, the strategy of associating computer functions with routine human activities has been generally well received.

Some Instructional Ideas

Before discussing the manner in which specific computing concepts can be introduced, the author would like to offer a few instructional ideas that have proved to be helpful in developing and maintaining student interest, and have promoted a confident feeling toward computing activities.

Idea I: Use analogies to tie what you are trying to get students to understand with what they already understand.

A major consequence of viewing computing as a fundamental human activity is that it makes it possible to introduce computing concepts in the context of everyday activities known to everyone.

Idea II: See if you can get students to discover the necessity for something and then invite them to invent it.

The point here is to emphasize the functional characteristics of a given computing concept and to motivate its existences by showing how it contributes to the solution of a problem in computing. For example, a language translation process becomes necessary when one wants to write programs in a language suitable to a given problem, but realizes that computers can execute only machine language. Thus, compilers and interpreters are motivated.

Idea III: Vary instructional media and activities.

Nothing leaves a student in a more passive frame of mind than a straight lecture approach to teaching. Students generally find a course more stimulating when there is a variety of styles of activity. It is particularly beneficial in a computing literacy course to get students doing something on the computer early in the course.

Idea IV: Use anonymous feedback exercises as a way of assessing class progress in the course.

Begin each class session with a short quiz on a couple of the main ideas from the previous session. Have students exchange with and mark their neighbor's paper as you are going over the answers. Tally the number right and wrong for each question. The point is not to evaluate individual student performance, but to get feedback on the progress of the class as a group. Thus, concepts not well understood by the class can be identified and reviewed on the spot before new material is presented.

Pre-Computer Computing Concepts

We now turn to the manner in which basic computing concepts might be introduced. The presentation has been intentionally designed to be independent of the computer itself as discussed earlier and should not take more than two class sessions. The major concepts that the pre-computer portion of the course introduces are summarized below:

(1) the general notions of input, process and output;

(2) the concept of a task and the problem defining and solving activities leading to their formulation;

(3) the concept of structuring complex tasks as an integrated system of more manageable subtasks;

(4) the concept of a procedure viewed as a well defined sequence of operations leading to the accomplishment of a task;

(5) the desirability of describing a procedure to facilitate person-to-person communication leading to the need for a notational convention or programming language;

(6) the concept of a program as a representation of a procedure in terms of a particular programming language;

(7) the development of criteria for evaluating program performance and suitability.

A useful method to illustrate the concepts given above is to select a commonly performed task and to subject it to critical analysis. This develops an appreciation for how a task can be better understood when it is broken down into more elementary components. Once a task has been selected the instructor can play the role of "robot" and challenge the class to teach him/her how to perform the task. Whether the task is to boil an egg or look up the meaning(s) of a word in a dictionary, the class will quickly encounter a variety of perplexing but instructive difficulties when attempting to arrive at a clear and comprehensive procedure which, when performed by the robot, will accomplish the task. Here are a few examples:

(1) What constitutes a well-defined task?

(2) Can all well-defined tasks be performed in a routine manner?

(3) What elementary operational structures (instruction set) are to be assumed?

(4) Is it possible for a procedure to produce correct results (output) when applied to one situation (input) but incorrect results when applied to a different situation?

(5) Is it possible to prove a procedure correct?

(6) How can a procedure be modified so that it can be applied to a broader class of problems, that is, how can a procedure be made more general?

(7) Can two different procedures be "functionally equivalent" in that they always produce identical results when applied to the same input?

(8) What factors should be taken into consideration when evaluating the performance of a procedure?

One outcome of such an exercise invariably results: the class gains new respect for the considerable subtly and complexity that characterizes person-to-person communication as compared to person-to-machine communication. Students are often surprised to discover that communicating with machines is a rather straightforward activity once you understand what it is that you wish to communicate. Addressing a computer system, then, boils down to learning the operational characteristics and conventions which have been designed into its hardware and software subsystems. When students understand this, the transition from computing in general to computing via the computer becomes a natural one.

Computing as the New Geometry

Probably every high school geometry student has questioned why it is important to know how to prove that a triangle is isosceles, given that two of its angles are equal. The answer, of course, is that it isn't important in itself, but an understanding of the discipline of geometry is valuable because it develops our ability to reason deductively. More generally, the primary rationale for geometry in the high school curriculum is that it provides a vehicle for transmitting a powerful skill.

In a similar vein, computing should have special relevance for educators. This is because computing focuses on the processes by which tasks are analyzed and performed in concrete operational terms. As educators seek to help students be more adaptive to an increasingly complex and changing world, additional emphasis will have to be placed on methods of inquiry and problem defining and solving skills. Computing provides an excellent framework for the development of those skills.

In addition to addressing problems at a strictly operational level, computing has the fascinating potential of contributing to our understanding and development of interpersonal skills. It is widely recognized that the successful implementation and operation of any complex computer-based system depends in large part on the manner in which interpersonal relations are handled. Each person involved with the system must have a realistic perception of his/her responsibilities and must be willing to make personal concessions if effective progress is to be made. This requires good communication skills and the ability to work well with people in a team effort. Many other non-computer-based activities are similar in this respect. Our society undoubtedly will place increased value on such joint problem solving behavior in the future.

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