Reprinted from —
AFIPS — Conference Proceedings
Volume 39

Montvale, N. J. 07645

Delphi and its potential impact on information systems

by MURRAY TUROFF

Office of Emergency Preparedness, Executive Offices of the President
Washington, D. C.

THE DELPHI METHOD[1,2]

The Delphi method is basically defined as a method for the systematic solicitation and collation of informed judgments on a particular topic. The concept of "informed" here could mean poor people, if the subject were poverty, as well as the usual interpretation of "experts." The method has two important characteristics which distinguish it considerably from a polling procedure. The first is *feedback*, where the judgments of the individuals are collected, possibly formulated as a group response and fed back. Thus, each individual may view the results and consider whether he wishes to contribute more to the information and/or reconsider his earlier views. This round or phase structure may go through three to five iterations in the usual paper and pencil exercise. The second characteristic is that all responses are anonymous. The reasons for *anonymity* are much discussed in the literature and will not be reviewed here. However, there are circumstances where complete anonymity could be relaxed. In some cases it may be useful for the respondents to know who is participating in order to insure awareness that a peer group is involved in the discussion. Also, when a highly specialized subtopic enters the discussion it may be appropriate to permit an expert to endorse an item.

The primary objective of the Delphi process, as set forth in this paper, is the establishment of a "meaningful" group communication structure. If this view is accepted as correct, then the question of whether or not a Delphi exercise will produce "truth" is not a relevant one. The real issue, given the context of a particular problem, is what communication process or combination of processes will be most effective in terms of the resources available to examine the problem.

There appear to be five situations where the Delphi method clearly has an advantage over other alternatives:

- Where the individuals needed to contribute knowledge to the examination of a complex problem have no history of adequate communication and the communication process must be structured to insure understanding;
- Where the problem is so broad that more individuals are needed than can meaningfully interact in a face-to-face exchange.
- Where disagreements among individuals are so severe that the communication process must be refereed.
- Where time is scarce for the individuals involved and/or geographical distances are large, thereby inhibiting frequent group meetings.
- Where a supplemental group communication process would be conducive to increasing the efficiency of the face-to-face meeting.

In order to emphasize the view that the Delphi is a communication process, Table I directly compares the properties of normal group communication modes and the non-automated and automated Delphi processes. The major differences lie in such areas as the ability of participants in a Delphi to interact with the group at their own convenience (i.e., random as opposed to co-incident), the ability to handle large groups, and the ability to structure the communication. With respect to time considerations, there is a certain degree of similarity between a Committee and a Delphi exercise since delays between meetings and rounds are unavoidable. Also, the Delphi Conference[3–6] may be viewed conceptually as a random (occurring) conference call with a written record automatically produced. It is interesting to observe that within the context of the normal operation of these communication modes in the typical organization, governmental or industrial, the Delphi process appears to provide the individual with the greatest degree of individuality or freedom from restrictions on his expressions.

While the Table breaks down these systems separately, there is no reason why the examination of a particular problem would not be best served by a combination of these techniques. For example, a Delphi

TABLE I—Group Communication Techniques

	Conference Telephone Call	Committee Meeting	Formal Conference or Seminar	Delphi Exercise	Delphi Conference
Effective Group Size	Small	Small to Medium	Small to Large	Small to Large	Small to Large
Occurrence of Interaction by Individual	Coincident with Group	Coincident with Group	Coincident with Group	Random	Random
Length of Interaction	Short	Medium to Long	Long	Short to Medium	Short
Number of Interactions	Multiple, as required by group	Multiple, necessary time delays between	Single	Multiple, necessary time delays between	Multiple, as required by individual
Normal Mode Range	Equality to Chairman Control (Flexible)	Equality to Chairman Control (Flexible)	Presentation (Directed)	Equality to Monitor Control (Structured)	Equality to Monitor Control or Group Control and no Monitor (Structured)
Principle Costs	Communications	—Travel —Individuals time	—Travel —Individuals time —Fees	—Monitortime —Clerical —Secretarial	—Communications —Computer Usage
Other Characteristics	Time Urgent Considerations	Forced Delays		Forced Delays	Time Urgent Considerations
	—Equal flow of information to and from all —Can maximize psychological effects		—Efficient Flow of Information from few to many	—Equal flow of information to and from all —Can minimize psychological effects —Can minimize time demanded of respondents or conferees	

Conference may be used between committee meetings to arrive at an agenda and expose the areas of agreement and disagreement. This, in turn, would improve the efficiency of time spent in the actual committee meeting by focusing the discussion on those areas requiring review. In some instances this would also improve the efficiency of staff work before the meeting.

Usually a Delphi communication process, whether it be an exercise or conference undergoes four distinct phases. The first phase is usually characterized by exploration of the subject under discussion wherein each individual contributes additional information he feels is pertinent to the issue. The second phase usually involves the process of reaching an understanding of how the group views the issue (i.e., where they agree or disagree and what they mean by relative terms such as importance, desirability or feasibility). If there is significant disagreement, then that disagreement is explored in the next phase to bring out underlying reasons for the differences and possibly to evaluate them. The last phase, a final evaluation, occurs when all previously gathered information has been initially evaluated and evaluations have been fed back for consideration.

The Delphi technique may be considered to have roots in the jury system and is, perhaps unfortunately, a rather simple idea. Because of this, many individuals have conducted one Delphi and only a few have gone on to do more than one. The process of designing a workable communication structure for a particular problem currently appears to be more an art than a science. However, a number of general reasons for failures have come to light from these less successful attempts:

- Utilizing a blank sheet of paper on the first round or phase and thereby implying that the respondents should waste their time in educating the design and monitor team;

- Poor techniques of summarizing and presenting the group response and insuring common interpretations of the evaluation scales utilized in the exercise;
- Ignoring and ot exploring disagreements so that discouraged dissenters drop out and an artificial consensus is generated;
- Ignoring the fact that respondents to a Delphi are acting in a consultant mode in what may be a demanding exercise and should therefore be involved as a part of their normal job function or should receive normal consulting fees for participation.

The use of the Delphi process appears to have increased at an exponential rate over the past five years and on the surface seems incompatible with the limited amount of controlled experimentation that has taken place on the methodology itself. It is, however, meeting a demand for improved communications among larger and/or geographically dispersed groups which cannot be satisfied by other available techniques. It also serves the decision maker who wishes to seek out the potential secondary effects of a decision or policy which may involve a more diverse group of experts than is normally available. Also, technologists have become increasingly concerned that attempts to evaluate cost-benefit aspects through mathematical models often eliminate significant technical factors which they may feel are crucial criteria for the making of a decision. The Delphi process can, in this context, be viewed as an attempt to put human judgment, in terms of a group judgment by experts, on a par with a page of computer output. This is an unfortunate justification for the Delphi process, but from a pragmatic point of view it is a valid one in terms of decision processes in some organizations.

It can be expected that the use of Delphi will continue to grow. From this one can observe that a body of knowledge is developing on how to structure the human communication process for particular types or classes of problems. The abuse, as well as the use, of the technique is contributing to the development of this design methodology. It would seem obvious that any communication structure that employs pencil, paper, and the mails can, in principle, be duplicated in a real time mode on an interactive terminal-oriented computer-communication system. When this is done the resulting product is a continuous group communication process which eliminates some of the disadvantages in the paper and pencil type Delphi while retaining most advantages. It is the contention of this author that those in the computer field should begin to actively plagiarize the techniques of the Delphi design area for building on-line conferencing systems tailored to various problem applications. The remainder of this paper attempts to support this assertion.

EXAMPLES*

In examining applications of the Delphi, one observes that the vast majority deal with forecasting the future. Because of this, many individuals associate the Delphi process solely with forecasting. However, in examining other Delphi exercises, one finds that they span a surprising diversity of applications:

- Examining the significance of historical events
- Gathering current and historical data
- Putting together the structure of a model
- Delineating the pros and cons associated with potential decision or policy options
- Developing causal relationships in complex economic or social phenomena
- Clarifying human interactions through role playing concepts.

If one adopts the view of Delphi as a communication tool, then this exhibited diversity of application is not surprising. A group communication process can, in theory, be applied to any problem area. The following will discuss some of these previous applications and indicate where they may lead in the future.

Dr. Williams of Johns Hopkins University has utilized the Delphi to obtain estimates of current rates of disease incidence and the success rate of various alternative treatments. Since hospital reports may reflect local reporting standards, there is considerable uncertainty associated with the data that is available. This phenomenon also occurs in other areas such as crime statistics. In applications of this sort, individuals are asked to supply low and high values as well as an explicit estimate. This type of exercise then proceeds in very much the form of a forecasting Delphi, although it deals with current data.

There are a surprising number of Delphi designers in the medical research and health care areas, some of these are Dr. A. Sheldon at Harvard, Dr. A. Bender at Smith Kline French, Dr. D. Gustafson at the University of Wisconsin, and Dr. G. Sideris, American Surgical Association.

A Recent Delphi on the Steel Industry[7] by the National Materials Advisory Board of the National Research Council also attempted to gather estimates on

* See Reference 1 for explicit references to the examples mentioned.

the quantity of material flowing in and out of various processing segments of the industry. In such a case, even when a parameter is published it may only represent a percent of the industry. This percent factor may be only approximately known.

A proprietary Delphi was done which dealt only with historical events affecting the subject of the "Limitation or Elimination of Internal-Combustion Vehicles." Some eighty-two events were compiled by the respondent group and evaluated for explicit significance and "factors to watch" as a result of the events. The events were technological, economical, social, and political. The resulting summary arranging the events chronologically represented an excellent review and condensation for management. This same concept could easily be applied to a professional area and the computer field is perhaps overdue for a careful review of the literature. For example, it is doubtful that anyone in the field can claim he has read all that has been written on Management Information Systems. Probably all would agree, however, that the signal to noise ratio is small. It would be interesting to see the list of significant papers drawn up by a group of experts, and to discover how they would identify papers representing follow-on work to earlier papers and further developments that may occur as indicated by a particular paper. One added benefit of the Delphi is that an expert need not feel embarrassed to propose or argue for his own papers as significant. It is not clear, of course, that the group would always vote to include a suggested paper.

The concept of utilizing Delphi to examine history is a simple but powerful concept. Most organizations do not really do a good job on evaluating past performance and this often defeats the purpose of their planning efforts. The author hopes more applications of this type will be forthcoming.

Mr. S. Scheele of the SET, Inc. designed and executed a fascinating Delphi on the Role of Mentally Retarded in Society. Since he was dealing with a non-quantitatively oriented group, he relied very heavily on pictorial models which the individuals could fill in in order to represent human and societal interactions. Also inherent in the design were role playing concepts and a requirement for the respondents in answering different questions to assume different roles. This same concept applies to obtaining answers from individuals in political or public position where one would wish to ask for the individual's true view on an issue and the view he would espouse if required to take a public position.

The role playing concept in the Delphi has implications for an organization in the sense that most budget allocation procedures may be viewed as a form of polling where each manager submits his requests to a central source. When budget cuts must be made, there is a great deal of competition among the divisional groups, often resulting in antagonism and a complete breakdown of lateral cooperation and communication. The budget process could be "carefully" recast in a Delphi mode and each manager asked to assume the roles of other managers and to attempt justification of budget segments other than his own. This could lead to more understanding of the final allocation for all concerned and correspondingly less antagonism. The validity of the above general suggestion is, however, extremely dependent upon the particular organization and details of the environment, operation, and makeup.

Norman Dalkey's "Quality of Life" Delphi is a classic simple example of utilizing a Delphi to obtain subjective evaluations which could not be gained by any analytic method. Here the respondents were asked to itemize and define a set of variables which comprised the Quality of Life and were measurable in at least an empirical sense. The feedback mechanism was necessary to arrive at mutually understandable definitions and the anonymity was desirable to avoid the embarrassment of individuals who might rate factors such as "aggression" higher than the group as a whole. The same type of Delphi was conducted on a group of corporate executives to determine if their ranking of the Quality of Life variables corresponded to the corporation executive benefit program.

Many individuals have a mistaken impression that consensus is a goal of all Delphi Exercises. When exploring policy or decision issues, the goal may be to develop the strongest set of pros and cons concerning a given issue. In a sense then, some policy Delphis seek to at least explore disagreement if not to directly foster it through the makeup of the respondent group. Even if a decision maker has reached a view on an issue, it may be of interest to him to seek out the opposing view to be forewarned of difficulties he may encounter when his decision is made public. The discovery of a consensus among opposing advocates on underlying issues or compromise positions may make the exercise doubly useful but may not be the primary goal.

In the steel Delphi mentioned earlier, the respondents were given a flow model diagram of steel processing which was intended to collect data on the flow of material in each path. The initial model was put together by an expert. However, many of the respondents to the exercise decided that the diagram was not sufficient to express what they felt were significant connections. As a result of the uninvited modification of the model, the diagram obtained after two Delphi rounds was considerably more detailed and realistic. This leads to the proposition that Delphi can be utilized to build model structures for complex processes. The difficulty with some of the plans for designing computer

graphic systems for group engineering design efforts is that the computer people often forget that the concept can be first tried with pencil and paper on a real-life problem to see if a workable communication structure would result. If it succeeds in a Delphi Exercise mode then there is a higher probability of success in the automated version. In many ways, the Delphi activity as it occurs today is conducting a significant experimentation program for the field of computer sciences. This fact appears to have, thus far, escaped the notice of most computer personnel. The general concept of pretesting an information system design by paper and pencil exercise before it is frozen in the concrete of our "flexible" computer system deserves more attention than it has received.

One very significant aspect of the Delphi area has been the design of attempts to discover views on causal relationships underlying complex physical, social, and/or economic systems. While many design techniques have been tested, one in particular has gained wide use because of the ease with which even non-quantitatively oriented individuals can supply answers. This communication format is generally referred to as "Cross Impact"[8] and involves a matrix formulation of causal effects where the user is asked to supply either probabilities, odds, or weights depending on the particulars of the formalism. While the approach is easy to use, the analysis of the results is less clear because one is asking only for a small, but feasible portion of the information required to rigorously specify the problem and therefore consistency checks can only be approximations. At least four different methods of analysis are currently being used. An important difference for some of these approaches is the ease with which the method can be incorporated into an interactive mode on a computer system. In experiments the author has conducted with a method of treatment suited for a computer, one finds that a non-programming user, by supplying answers to a cross impact form, can in effect build his own model of the future which he can then subject to perturbations to see the effects of alternative decisions or policy. This becomes very useful as an aid to the thinking through of a complex situation. The interactive feature is extremely important in allowing an individual to modify his initial estimates until he feels he has obtained consistency between these and the inferences provided by the analytic treatment. Once a user is satisfied with the estimates obtained in this one-person game mode, they may be applied automatically to the formation of a group estimate and may allow individuals to see the differences in judgment that may occur for both the magnitude and the direction of the causal effects. This process quickly focuses the group's attention on areas of either disagreement or uncertainty which then may be discussed in a committee process or a general discussion-oriented Delphi.

The particular utility of the cross impact formalism in a planning environment will become evident in the next section.

In terms of the author's knowledge alone, there are at least thirty distinctive Delphi designs which have been successfully applied to particular problem areas. Each one of these is a potential candidate for automation on a terminal-oriented computer system in order to implement a real time conference system. While many of these require graphical input, a sizable number can be implemented utilizing the common teletype terminal. When the computer is introduced we also introduce the ability to provide for the Delphi respondent both analytical tools and selective data bases which he may utilize to sharpen his judgments before they are contributed to the group response.

A significant observable effect of a computerized conference system is the group pressure to restrict discussion to the meat of the issue. Verbose statements always tend to receive low acceptance votes and individuals quickly learn, because of this, to sharpen their position if they wish to make a point.

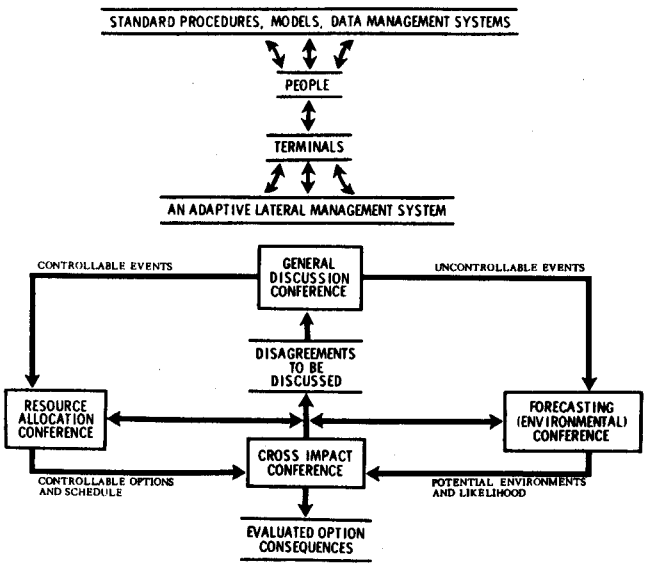
Putting all these factors together with the real time nature of such a system, we can begin to visual the results as approaching something that might be termined a "collective human intelligence" capability. In terms of the current state of the art in the computer field there may be a great deal more pay-off in easing the ability of humans to contribute the intelligence to the computer than in attempting to get the computer to simulate intelligence.

INFORMATION SYSTEMS

In most organizations today, the individuals or groups involved in forecasting and/or planning* usually exhibit the greatest desire to foster lateral communication. This often comes from a realization that uncertainties and ancillary considerations must be carefully explored if the organization is to avoid problems in the future. The desire to seek out the specialists in the organization regardless of where they sit, combined with the requirement to minimize the time they must give up from their normal functions, has led to an increasing use of the Delphi by the forecasting groups.

---

* The exception to this generality occurs when there is a belief that planning or forecasting can be reduced to only the consideration of dollars and alternative dollar equivalents or investments. Perhaps more organizations take this view than is warranted by their situation.



Ffgure 1

Due to the increasingly complex environment that most organizations face today, a similar circumstance has developed with respect to day-to-day management functions. The need for committee participation is beginning to make heavy demands upon the time of many managers. While the paper and pencil Delphi process has been introduced in some cases to alleviate the situation, it does not always meet the time urgent requirements associated with some management activities. These seems, therefore, to be a rapidly increasing interest in implementing more efficient communication techniques to deal with complex management problems. The automated Delphi or Delphi Conferencing may very well be the answer to this problem. In fact, one can conceptually lay out a highly adaptive Management Information System based upon this view.

Given that the organization has a problem to be examined and resolved, the first step is to pinpoint the individuals who can contribute to the process independent of their organizational or geographical location. They, as individuals, may contribute via terminals at their convenience to a general discussion conference (see Figure 1).

Requests for information on the potential environment (i.e., those factors not under control of the organization) will emerge from this discussion. These requests are shifted to a specialized conference structure which may involve only a subset of the general conference group and other specialists as needed. The communication structure for this forecasting conference is probably typical of many of the forecasting Delphis already in existence.

Potential program options would also evolve from the general discussion conference. These options would be shifted to another secondary or specialized conference to evaluate questions of resource allocation within the organization. This type of conference would possibly have various analytical support routines involving optimal allocation of resources among combinations of program options.

In both the resource allocation and forecasting conferences one would expect uncertainties or disagreements to occur which should be fed back to the general discussion conference for resolution. The results of these efforts would be a set of program options and potential environments which may now be played off, one against the other, in a conference structured along the lines of a 'Cross Impact' exercise.

In this third conference, additional uncertainties and disagreements may arise to be fed back to the general discussion conference. It is also possible, if not likely, that the results of the cross impact may trigger the requirement to introduce new program options or to examine a newly introduced aspect of the environment. One then views the interaction of these four conference structures as a continuous communication and feedback structure.

This basic set of four conferences may be replicated for each problem the organization wishes to put through this process. Therefore any one individual may be involved in a number of different problems. Also, a particular problem may be perpetual in nature so that the activity never stops but different individuals may enter and leave the discussion as a need for their particular speciality arises and is satisfied. The result of this is a highly adaptive and flexible structure for problem solving which the author feels exhibits all the characteristics of a Management Information System or what MIS should be.

The underlying premise behind the adoption of such a system is that while the organization may have elaborate data management systems and simulations or models, there are no algorithms allowing the data flowing through the normal organization procedure to automatically be transformed into a form directly suitable for addressing management problems as they occur. The view here is that individuals provide the best available mechanism for discriminating, reorganizing and presenting the portion of the data needed for problem consideration.

The problem that appears to exist in many current MIS efforts is the view that it is possible to introduce automation to the point where the person at the top can press a few keys on the terminal and all the pertinent data in a form appropriate to his problem will be retrieved. This is true only to the extent one believes

that all the problems that will be considered can be predefined.

Most of the current MIS efforts are based upon what the philosophy of science people would term a 'Leibnitzian Inquiring System'[9] where the approach is to believe that one can construct a model of a physical process independent of the data inputs. This view underlies the mathematical and physical sciences, and the attempt of the soft sciences, including the management sciences, to emulate this philosophy has perhaps created some of the problems in applying work in this area to real problems.

It is of interest to note that any particular Delphi design, or communication structure can be characterized in terms of one of the Inquiring Systems specified in Churchman's writings. However, very few Delphis fall into the category of being Leibnitzian since there is usually a basic recognition in Delphi structures that the problem and data are inseparable. The policy type Delphi can, for example, be characterized as a "Hegelian Inquirer" which in its extreme assumes that any particular data, through its representation, can be used to support contrary positions. Information is considered fundamentally, in this view, as a property of the conflict between contesting points of view.

The lateral management system that this paper has attempted to describe can be viewed as what has been termed a "Singer-Churchmanian Inquirer" where it is assumed that "there are a multiplicity of models, theories, and inquirers for looking at the world, no one of which has *absolute* priority over the other". With this view, one is quickly forced to the position that each new problem must be examined within the context of the available information and potential analysis tools in order to arrive at a treatment. Therefore, we must utilize the only information processor which can evaluate* among alternative approaches—humans.

When one realizes that a majority of the efforts associated with trying to apply computer systems to the problems facing organizations are based upon a Leibnitzian Inquiring philosophy, then one of the little known, but crucial dangers associated with computer systems becomes clear. Organizations are forced, by both accounting requirements and command (i.e., focusing of responsibility) requirements, into adopting a hierarchical structure. Because the environment confronting these organizations has become increasingly complex the resulting structure does not often match the problems that arise. The usual Leibnitzian reaction to this situation is to reorganize so that a new structure fitting the problem emerges. Because structures, especially if they retain the hierarchical property, are fairly rigid, and the situation today is characterized by numerous problems wherein no one structure is common to all, these attempts to reorganize do not usually accomplish the desired goal.

Since organizations are made up of at least a subset of intelligent human beings, the inadequacies of the organizational structure and the resulting established communication channels are at least obvious to some. The result is a growing lack in many organizations of effective communications about various problems. The individual perceiving the situation faces a choice of either establishing informal communication channels and perhaps suffering consequences for bypassing the established modes or suffering in silence and adapting a game-playing attitude toward the communication process available to him. When this latter attitude is characteristic of a large segment of the organization, there is no longer an effective human communication process and individuals become extremely unresponsive to attempts to effectively deal with problems. This is further complicated in times of tight budgets where there is competition for resources among different segments of the organization.

Given the above situation in an organization, what happens when a computerized Management Information System designed along Leibnitzian lines is introduced? A well designed system of this sort gives the illusion of intelligence by being very responsive to the individuals communicating with it. Since it is data independent it can translate any input data provided by the humans into an apparently original output or consequence. Psychologists would possibly agree that given the alternative of an unresponsive human communication process or a responsive man-machine communication process most individuals will shift their efforts at communication to the machine. We then find the computer becoming a surrogate for a repressed individual desire for effective communication. In addition, since the Leibnitzian view of the world appears invalid for the type of problems confronting most organizations, then the introduction of a Management Information System based on this concept is a form of deception. The result is that the human is still playing a game, although with the computer he may be less aware the existence of the game than in the process of dealing with humans.

What the author therefore believes to be a real danger of computer usage over the long term is the ability of these systems to subjugate the desire to treat problems associated with human communications in organization by providing an image that an effective communication process exists. There is the possibility of a world ten to twenty years hence where a majority

* In the sense of applying value to the alternative approaches.

of the professional populace believes it is performing a useful function, but is, in fact, engaged in a game from which no tangible benefits result.

USER REQUIREMENTS FOR CONFERENCING[10]

The first and paramount requirement is that the designer of a conference structure have available a user oriented language (i.e., BASIC, JOSS, APL, TINT, etc.) in which the conference can be programmed. The general rule about conferencing systems is that any group of users will, through experience, have a considerable number of modifications to make. Also, it can be expected that a new type of problem may dictate a new communication structure. The role of the computer specialist should be to provide those features in a user language and machine executive which will allow the designer the flexibility of programming communication structures which may be intertwined with simple or complex analytical expressions (i.e., from vote averaging to optimization models). The basic system requirements are twofold and very similar to those required for on-line simulations involving a group of humans:

(1) Simultaneous attempts by two or more individuals at separate terminals to write in the same file should not cause garbling of the file.
(2) Errors in input or noise on the line should not confuse the user by throwing him out of the program and into the compiler or executive program.

There are several ways to meet the requirements. Summarized here are the particular features available in XBASIC* on the UNIVAC 1108 that allow the writing of conferencing systems.

An XBASIC program can execute a subset of the executive level commands on the 1108. This capability is helpful in allowing the program to assign the common file exclusively (using the executive command) for a short time (less than a second) to the conferee who is inputing data at that moment. The program then frees the file for any other conferees desiring to write in it. This simple feature solves the first requirement.

In order for the interaction program to do all the error checking, a full capability for decoding strings is required. Everything (even a number) entered via the terminal or via noise on the communication line is read as a string and checked for allowed choices. Therefore, the ability to accomplish string manipulation and provide storage of string variables is required.

Output, especially for non-programmers, must be neat. Therefore, format or form control, such as is provided in FORTRAN or JOSS, for example, must be part of the language.

A good test of the sufficiency of the string handling capabilities in a user language is provided by examining the difficulty of writing one of the standard interactive text editors in the user language.

Although the above items are sufficient, a number of other features will make things easier or more efficient. Many of these are covered in Hall's paper in the 1971 SJCC proceedings.[4]

Many computer professionals appear to have believed until now that any user can be placed in one of five categories. The user does calculations, or he looks at data, or he manipulates strings, or he edits text, or he files things away; but he always does just one of these things, and the system capabilities are slanted accordingly. All the users I have ever encountered seem to do all the above in their daily non-computer chores. It is time for user languages to reflect a more realistic picture of users and their requirements.

If computer conferencing is to be a successful operation, the design and modification of conference structures with respect to the dictates of the problem being examined must be largely carried out by the users. Once a successful structure has evolved, a good systems programmer will have a role in making the overall operation efficient, provided the system is to receive long term use.

* Proprietary processor developed by Language and Systems Development Inc.

REFERENCES

1 A more detailed discussion of the Delphi and a comprehensive bibliography of this area may be found in *The Design of a Policy Delphi* by Murray Turoff, Journal of Technological Forecasting and Social Change, Vol. 2, No. 2, 1970.
2 A comparison of Delphi as a planning tool with other planning tools may be found in *Technological Forecasting and Engineering Materials* by the Committee on Technological Forecasting of the National Materials Advisory Board of the National Research Council, NMAB-279, December 1970.
3 The history of a particular Delphi Conference application may be found in *Delphi Conferencing (i.e., Computer Based Conferencing with Anonymity)* by Murray Turoff, Journal of Technological Forecasting and Social Change, Vol. 3, No. 2, 1971 (publisher: American Elsivier). This paper contains the complete design of the user interaction.
4 Details on implementing the above conference system on a computer may be found in *Implementation of an Interactive Conference System* by Thomas W. Hall, Proceedings of the 1971 Spring Joint Computer Conference.

5 An abbreviated report on this topic may be found in *Industrial Applications of Technological Forecasting and its use in R&D Management*, Wiley 1971, edited by M. Cetron and C. Ralph.
6 An explanation of the Delphi Conferencing concept for the layman is available in the April 1971 issue of the Futurist (magazine of the World Future Society, Washington, D. C.).
7 Two other large recent Delphis (involving 40 to 100 experts) reviewing the potential future of an industrial sector was one on computers by IBM and one on the Housing Industry by Selwyn Enzer of the Institute for the Future. See *Some Prospects for Residential Housing by 1985*, IFF report R–13, January 1971. The "Delphi Exploration of the Ferroalloy and Steel Industry" should be available from NMAB in late 71 and contains a detailed history of the effort involved in carrying out a large scale Delphi exercise.
8 For a review of this literature see *An Alternative Approach to Cross Impact Analyses* by Murray Turoff, Submitted to the Journal of Technological Forecasting for publication early 1972. This paper also illustrates the use of Cross Impact in an information system context.
9 See *What is Information? A Philosophical Analysis* by Jan J. Mitroff, Interdisciplinary Program in Information Sciences, University of Pittsburgh (to be published). Also the writings on Inquiring Systems by C. West Churchman (Internal working papers 28, 29, 45, 46, 49 on Inquiring Systems, Space Sciences Lab., University of California Berkeley, to be compiled in a book).
10 The author has discussed some of these issues earlier: *Immediate Access and the User*, Datamation, August 1966 and *Immediate Access and the User Revisiated*, Datamation May 1969.

OTHER REFERENCE MATERIAL

Most of the current literature on Delphi appears in the *Journal of Technological Forecasting and Social Change*, *Futures*, or the *Futurist* (the magazine of the World Future Society). The World Future Society also runs a supplemental bulletin in which on-going work is reported usually long before publication.

The Institute for the Future is doing continuing work on applying the Delphi to fairly complex problems. Their reports and working papers should be of considerable interest to anyone planning to utilize the technique on a large scale problem.

Norman Dalkey at RAND has been carrying on a continuing series of experiments on the methodology and many of his recent papers are mandatory reading for potential practitioners.

The following items are meant to augment the extensive bibliography already available in the paper: *The Design of a Policy Delphi.*

A recent OEO report discusses the role of Delphi Conferencing as a component of an "Executive Information System", for the Governor of Wisconsin:

- *GENIE* (*Government Executives Normative Information Expediter*) by D. Sam Scheele*, Vincient De Sante and Edward Glasser, March 1971.

A version of the Delphi Conferencing System has been implemented in TRAC on the PDP-10 by Claude Kagan of Western Electric Research, Princeton, N.J..

The proceedings of the First General Assembly of the World Future Society (held in May of 1971 in Washington, D.C., and to be published late 1971 or early 1972) contain two papers of interest:

- *On the Design of Inquiring System—A Guide to Information Systems of the Future* by Ian I. Mitroff.
- *Three-Hundred and Seventy-Third Meeting of the Council on Social and Economic Cybernetic Stability in the Year 2011* by Murray Turoff.

The first provides a review and literature guide to the concept of "Inquiring Systems" and the second is a forecasting scenario which carries some current tendencies in the computer field to their dangerous, but perhaps logical, extreme.

Prof. Mitroff also has a paper in Vol. 17, No. 10, June 1971 issue of *Management Science* which deals with a particular application of a Hegelian Inquirer:

- *A Communication Model of Dialectal Inquiring Systems—A Strategy for Strategic Planning.*

The 1971 IFORS (International Federation of Operations Research Societies) meeting on Cost Effectiveness held in May of 1971 in Washington, D.C., had a working session on Delphi. (The proceedings should be published in 1972 by Wiley.) The report on the working session provides a synopsis on the Delphi method and also reports on an experiment held in the session where the audience voted (as to agreement or disagreement) with respect to twenty-one conclusions contained in a technical presentation. The vote was taken both before and after the presentation. This modified form of Delphi provided a clear measure of the effectiveness of the presentation and its utility as an educational experience for the audience. One cannot help but conjecture that extensive use of this technique at professional meetings might either significantly decrease the number of papers

* Mr. Scheele (Social Engineering Technology Inc., L.A.) presented this concept at a session in the SJCC 1971; it is not, however, available in those proceedings.

submitted or significantly improve the quality of the presentations.

The IFORS proceedings also contain a review article on Multidimensional Scaling and its potential use in Delphis by J. Douglas Carroll of Bell Telephone Laboratories. Work of this sort in the field of psychology is pertinent to using the Delphi for obtaining value judgments.

Those interested in the use of Delphi in social indicators should examine:

- *Experimental Assessment of Delphi Procedures with Group Value Judgments* by Norman Dalkey and Daniel Rourke, RAND Report R-6-12-ARPA, February 1971.

Two recent attempts to validate Delphi exercises with respect to "real" applications were carried out by Dr. John W. Williamson of the School of Hygiene and Public Health, Johns Hopkins University. These were:

- *Prognostic Epidemiology of Breast Cancer* and *Prognostic Epidemiology of Absenteeism*

A recent Delphi of interest to the computer field is:

- *A Delphi Inquiry into the Future Economic Risks of Computer-Based Systems* Institute for the Future, Middletown, Connecticut.

There is considerable activity in the use or potential use of Delphi in the area of regional or urban planning. An example of this may be found in:

- *Sea Grant Delphi Exercises: Techniques for Utilizing Informed Judgments of a Multi-Disciplinary Team of Researchers*, by John D. Ludlow, Bureau of Business Research, University of Michigan, Working Paper 22, Jan. 1971.

A number of county governments are utilizing the Delphi technique internally.

The Delphi literature has become quite rich in recent years with respect to the diversity of applications. One can quite easily be amazed at the number of information systems being designed and utilized without the use of a computer. This is especially significant if one concludes, as I have, that many of these designs are closer to meeting MIS requirements than other activities designed on computers and labeled as MIS.