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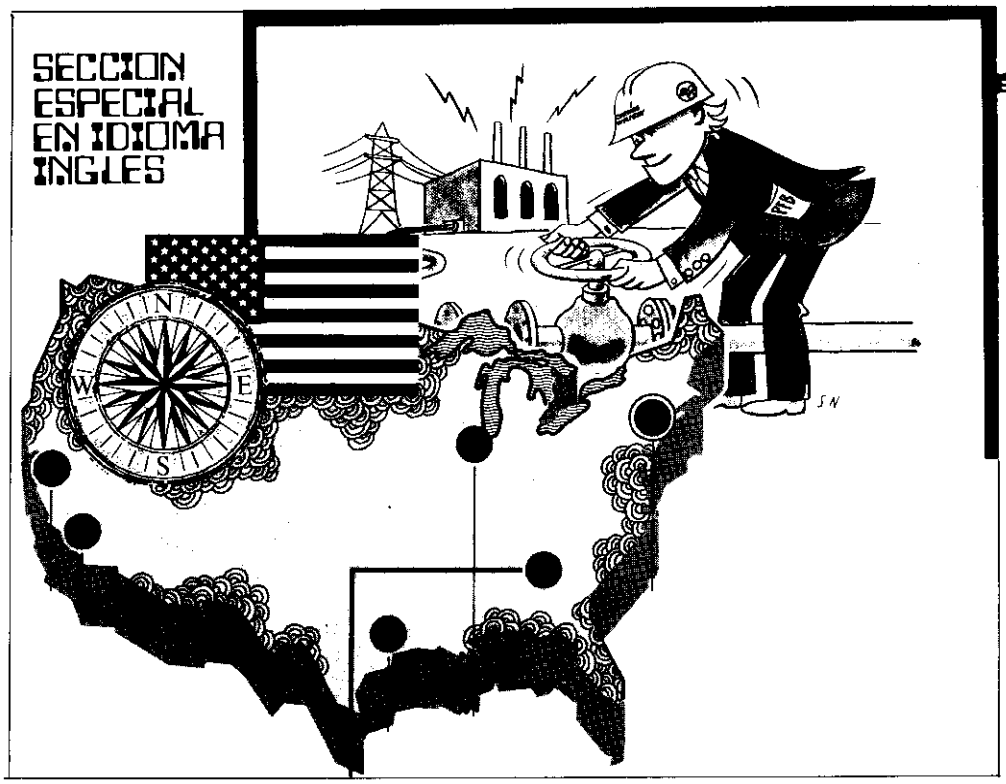


*Long-range forecasts in rapidly changing, high-technology areas are the most difficult of all forecasts. But given appropriate time and resources, the Delphi technique provides an excellent means of accomplishing this task.*

# A ten-year Delphi forecast in the electronics industry

**Jeffrey L.Johnson**

THE FIRST STEP in implementing the Delphi technique is to obtain panel members. Research indicates that a panel of 10 to 15 experts in a given field is sufficient to produce reliable results.

Next, an open-ended questionnaire (here called the initial-stage questionnaire) is sent out to panel members. It asks for descriptions of specific events forecasted to occur in the area in question. When the results are received, the administrator edits and summarizes the responses and draws up a list of events, clearly stated, which become the basis for the next or first-round questionnaire.

The panel members are requested to answer the first-round questionnaire with estimates of the dates by which the events in the list will occur and to give the major reasons for their answers. When the results are in, the administrator prepares a statistical summary of the dates forecasted by the panel and also prepares a summary of the reasons given for the various answers. The second-round questionnaire consists of the same list of events, the first-round panel median date, and the upper- and lower-quartile dates for each event plus the summary of reasons given by panel members for their answers.

Panel members are asked to answer the second-round questionnaire as before, considering the statistics and rationale resulting from the first round. They are permitted to either change or stay with their original answers. If their new answer on an event falls outside the quartile limits of the statistics from the previous round, they are again asked to give the major reasons for their answer and to respond to the comments given by those with different views. When the results are received, the director prepares a statistical summary and a summary of the reasons and comments. These results, in addition to the list of events, become the third-round questionnaire.

The theory behind the process is that with each additional round, the range of responses will narrow on each event as panel members gain new knowledge from the interaction. At

the very least, when the range remains wide, the assumptions and reasons for this diversity of opinion will be understood. Theoretically, the process of summarizing statistics and reasons and sending out a new questionnaire can continue indefinitely until no change in statistics occurs and no new information is received in the arguments. But past Delphi studies indicate that very little benefit is gained from sending out the list-of-events questionnaire more than three times.

**Accuracy of Delphi**

The Delphi technique first received attention in the early 1960s, and its major application is in long-term forecasting. Therefore, at this time, there is not much data with which to judge the long-term accuracy of Delphi forecasts. However, work has been done to evaluate the Delphi process in simulated forecasts, and the major conclusion from these experiments is that the group median obtained from the Delphi process is usually more accurate than the median obtained from individual responses.

**Obtaining panel members**

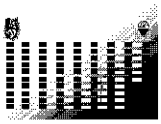
The first decision is whether the panel members are to be selected from inside your own organization or if outside experts are necessary. The primary considerations in making this decision are:

- Must the forecast to be obtained from this project be kept secret to be effective for your organization?
- Are there enough "experts" with a wide enough range of experience within your organization to staff a knowledgeable panel?

The next task is to identify a list of "experts" by name, then select the people to approach from this list. The major goal is to strive to obtain members with a wide variety of backgrounds and positions in the subject area.

The success of a Delphi study depends on continued and dedicated participation by panel members. It is therefore necessary to obtain their commitment before sending out the initial-stage questionnaire. In obtaining their commitment, three areas should be covered:

- An explanation of the Delphi process—why this technique is being used, how it works, and an estimate of the time and effort that will be required from panel members.
- The objective of the Delphi study—why this research is being done, how it is going to be used, and how it will benefit the organization running the study.
- How participation will benefit panel members. True commitment can only be ensured if there is some return to panel members for their time and effort. Depending on the subject area and the panel member's job and interests, there are several possible motivations: (1) Panel members will learn about the Delphi method and may later find it useful in doing their own forecasting. (2) Since the Delphi process is based on feedback and interaction, each panel member has the opportunity to learn as much as the organization running the study. Panel members will be receiving feedback on their own ideas, information from other experts in the same field, plus a forecast of the future. They could never



hope to obtain this information on their own for the same amount of effort individually. (3) If the information from the Delphi study is not useful to panel members, their payment must be more "worldly"—either a gift or payment in money. Panel members should be considered as consultants to be paid for their time and effort.

**Delphi operation**

Running a good Delphi study is not easy. There are several pitfalls that must be avoided.

The events questions in the "rounds" questionnaire must be worded very carefully to ensure that they are interpreted the same by all panel members. Any question that allows a variance in answers because of different interpretations of its meaning is undesirable. Ambiguous terms such as "common," "significant," "widely used," and "normal," should never be used.

Questions containing compound events must be avoided. If a panel member thinks one way about one part of a question and a different way about another part, good information will be lost. For example, questions like "Do you think football and baseball will grow, remain the same, or decline in popularity?" or "By what year will manned nuclear-powered rockets reach the planet Mars?" can cause confusion and yield misleading answers. (For the second question, what is really important? A manned expedition to Mars, or a nuclear-powered rocket reaching Mars?)

The questionnaire should be "easy" to fill out. That is, the format should be easy to follow and read; answers should be multiple choice or "fill in the blank" wherever possible; there should be sufficient space next to the question for any written comments desired; instructions and comments from previous rounds should be structured for the convenience of the panel members; self-addressed, stamped envelopes for returning the questionnaire should be provided.

Under no circumstances should the director give his opinion on the questions to panel members. They were picked for their expertise and should not need his advice, which would only bias the study toward the opinions held by the director. If the director concludes that the panel is missing important points, then he must also conclude that he has not done a good job of selecting his panel members. He should then start over with a new panel or add new people to the old panel.

No panel member should know the identity of any other panel member. This anonymity ensures that ideas and opinions will be judged solely on their merit.

**Corning's experience**

The original Delphi process was developed to forecast discrete events for which it was possible to estimate a specific date. In the industrial world, however, changes of interest usually take place gradually over a period of time, making a specific date of occurrence much more difficult to identify. Thus it is much more useful to pick a specific date of interest and ask panel members to estimate the *extent* to which a change will have taken place by that time.

In the Delphi study undertaken for forecasting electronics sales for Corning Glass Works, the technique

used was to ask for the extent to which an event will have occurred five and ten years in the future. This technique resulted in useful forecasts on gradually changing events for two specific points in time. Using the two "snapshots" in time also made it possible to look at trends over time. In other words, it was possible to forecast the rate at which an event was changing within the time horizon of interest.

In considering whether to use "inside" or "outside" experts for the study, it was apparent that the expertise available within Corning was not diverse enough to provide a balanced panel. Therefore, outside experts were needed. Two other concerns then arose: The electronics industry is so diversified that it appeared unreasonable to find individuals with detailed enough knowledge in all areas to qualify as "experts" and the results of the study might fall into the hands of competitors, thereby reducing its value to Corning. These two concerns were met by setting up three different panels—one for consumer-oriented electronics businesses, one for industrial businesses, and one for government businesses. This narrowed the range of experience necessary for the "experts" and also reduced the chances that any one competitor would obtain the results of the full study.

The process of generating a list of "experts" required considerable effort. Sources for names of experts were: electronics division sales and marketing personnel, sales and marketing people in other CGW divisions, and articles in trade journals. In all, a list of over 160 names was generated from which the needed panel members could be selected. A total of 62 people were personally contacted, and 52 agreed to participate in the survey.

**The pluses**

In particular, the areas in which the Delphi technique excelled were:

*1. Quantity of information from many disciplines.* In total, 44 panel members distributed through many industries and functional backgrounds participated directly in the Delphi study. Many of the panel members contacted others in their companies to help answer questions in areas with which they were not familiar. The volume and diversity of the information obtained would have been extremely difficult to equal using any other technique.

*2. Movement toward consensus.* One problem a researcher faces is trying to make a single forecast using data received from many sources with divergent opinions. The Delphi technique, in theory, should move panel members toward consensus, which is just what happened. Over 80 percent of the questions had a high degree of consensus at the beginning or moved toward consensus over the three rounds. The answers diverged between the first and third rounds on less than 2 percent of the questions.

*3. Comments on rationale for answers.* Two major forces that act in moving the panel toward consensus are statistics and explanations: When a panel member sees himself in a minority and does not feel strongly about his position, this alone may be enough for him to change his answer. But he may have even better reason if the rationale for the different answer is given. He now has new facts on

which to base his answer. This is also the only way the "minority" answer—which may be correct—can become the consensus answer. The comments on the answers appeared to be effective in moving the panel toward consensus. Quite often, the movement was toward one extreme or the other—not simply to the original majority answer.

*4. High commitment by panel members.* The panel members who participated were interested and highly committed to the study. This was indicated by the amount of time spent on the study (the average panel member spent over seven hours in total) and by the low dropout rate (about 90 percent of the panel members who began participating stayed with the study through the third round).

**The minuses**

The biggest criticism involved the time estimate for the study. The original estimate was six months; the actual time taken was nine months (including preplanning and the final report writing). The major contributing factor to this overrun was gross miscalculation of the rate at which questionnaires would be returned. The original estimate was four weeks for the initial-stage and two weeks for each of the rounds questionnaires. It actually took nine weeks to get all the initial-stage questionnaires back, and seven, five, and six weeks, respectively, for the first-, second-, and third-round questionnaires.

There were three other specifics to be criticized:

- Despite the efforts to make the wording of all questions clear, a few were interpreted in different ways. More time should have been spent in making sure the questions were unambiguous.
- The instructions in one area of the questionnaire were misinterpreted by several panelists. This was quickly evident from their responses and an additional explanation given to those who made the misinterpretation. However, the initial instructions should have been more clear.
- There were too many questions in the rounds questionnaires. The ideal Delphi should have about twenty-five questions; the Corning Study had close to 100. A shorter questionnaire would probably have generated more written comments.

**The lesson**

In summary, experience from this Delphi study indicates that future Delphi administrators should beware of three problem areas:

- Make sure there is sufficient time planned for the responses. About six weeks per round is required, plus one week to prepare for the next round.
- Plan for a sufficient staff to handle the workload. With one panel, a single staff member plus secretarial help is enough. But with more than one panel, additional help is necessary. At least one person on the staff should be able to type and keypunch (assuming computer programs are to be used).
- Several people should go over the questions and instructions on the rounds questionnaires and actually fill them out to detect any ambiguities. •

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