Flow Charts: A Tool for Developing and Understanding Survey Questionnaires

Thomas B. Jabine¹

Abstract: The preparation of flow charts is a useful tool in developing and understanding survey questionnaires. Summary flow charts can be used to lay out the broad structure of a questionnaire. Subsequently, more detailed flow charts can be used to analyze the sequence and relationships of individual questions. Frequently, flow chart features are incorporated in the questionnaire itself. The use of flow

charts is especially important for surveys using a computer-assisted telephone interviewing (CATI) system. This article describes each of these uses of flow charts and includes several examples.

Key words: Flow charts; survey questionnaires.

1. Introduction

A flow chart or diagram is a schematic representation of a formal process, program or system. As implied by the word "flow," it generally depicts the sequence in which various operations are or may be carried out and the logical relationships among them. In many systems there are conditional relationships, e.g., the next step may depend on what has happened earlier. Flow charts make clear the logic of such branching processes. In general, they are a useful tool for persons who design and use complex systems, i.e., those that have many distinct operations and complex branching patterns.

A survey interview using one or more questionnaires is a process which is well-adapted to flow charting. The questionnaires are usually highly structured, requiring interviewers to ask the questions in a specific order. In many household surveys, informa-

tion is collected on a single questionnaire for all members of a household. Sometimes, depending on the respondent rules established for the interviews, several different persons in the household may be asked to supply information. Frequently there are questions that do not apply to all persons, so that branching is necessary. In the development of the computer program that takes the place of a paper questionnaire in a computer-assisted telephone interviewing (CATI) system, preparation of a flow chart is a virtually mandatory first step. It seems evident, then, that flow charts are a potentially valuable and (sometimes) essential tool in survey research for those who develop, review and use questionnaires.

Nevertheless, there is little mention of flow charts in the survey research literature. The first reference that came to the author's attention (and was responsible for awakening his interest in the subject) was the handbook *Designing Forms for Demographic Surveys* by Sirken (1972). This handbook includes several illustrations of the use of flow charts to chart

¹ Statistical Consultant, Washington D.C., U.S.A.

the logic of survey interviews and to develop the structure of a questionnaire. Later illustrations of the use of flow charts in questionnaire development are found in a training manual for population censuses developed by the U.S. Bureau of the Census (1979), in Casley and Lury (1981), and in a draft manual on questionnaire design from the United Nations (1984).

The first published examples of flow charts of questionnaires show their use at the early stages of questionnaire development. Sirken used flow charts effectively to explore alternative structures and sequences for basic questionnaire "modules," i.e., sets of questions on distinct topics. The author has found that more detailed flow charts can be equally effective at later stages of development, e.g., in reviewing successive drafts of a questionnaire. Illustrations of both kinds of use are given below.

There are other ways, in addition to guiding questionnaire development, in which flow charts and flow-charting techniques can be useful in survey research. Flow charts of complex questionnaires can be used in training to help the interviewing staff get a broad view of the structure and flow of a questionnaire before launching into a more detailed study of individual items. Flow-chart features are sometimes incorporated in the questionnaire itself to make it easier for interviewers or respondents to follow the sequence of questions and the branching paths.

The purpose of this article is to try to remedy the failure of standard survey research texts to cover the subject of flow charts by presenting some practical illustrations of how they can and are being used by various practitioners of survey research. The coverage is limited to uses of flow charts directly related to questionnaires. Readers will of course recognize that flow charts have other important

uses in surveys, such as in scheduling survey operations and in developing processing systems.

2. Flow Charting a Questionnaire

One need not be overly dogmatic about the specific conventions to be used in preparing flow charts of questionnaires, as long as the results are clear and usable for the intended purpose. Nevertheless, there are some commonly used conventions and it will be helpful to stick to these whenever possible.

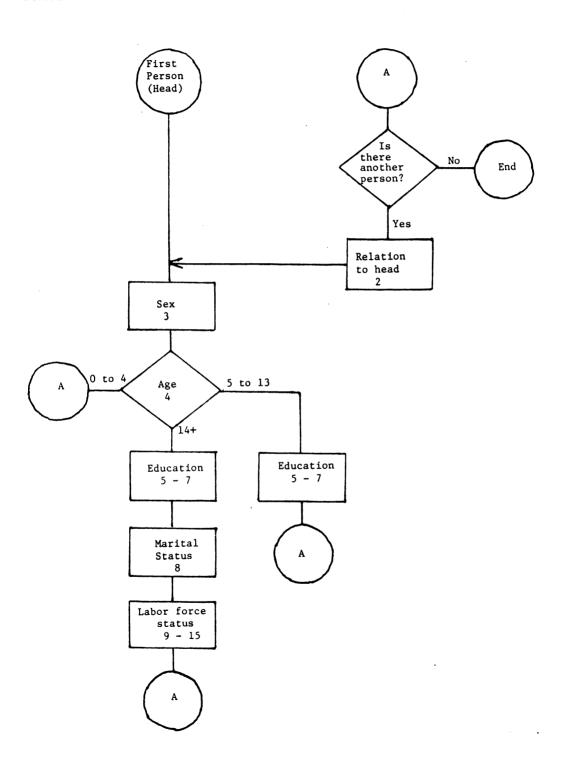
Fig. 1 illustrates the basic conventions with a flow chart of a relatively simple hypothetical questionnaire. The questionnaire represented by the flow chart is intended for collection of basic demographic and labour force information for all members of a sample household. Some of the information will be obtained for all persons; other information will be collected only for those in certain age ranges. Some of the topics require only a single question, others will require a set of questions. The topics, age ranges, and assumed item numbers are as follow:

Торіс	Age range	Item Numbers ¹	
Relationship	Allages	2	
Sex	All ages	3	
Age	All ages	4	
Education	5 and over	5 to 7	
Marital status	14 and over	8	
Labour force status	14 and over	9 to 15	

¹ Item 1 is assumed to be the person's name.

The framework of the flow chart in Fig. 1 consists of three kinds of geometric figures connected by lines. Circles (or more generally ellipses) are used to represent starting points, ending points and exit-reentry links. In this diagram, whenever one reaches an exit point labelled A, one returns to entry point A at the upper right. Rectangles are used to show individual questionnaire items or groups of

Fig. 1. Flow Chart for a Simple Household Questionnaire to Collect Demographic and Labor Force Data



items, provided that eligibility for other topics does not depend on the responses for that topic. "Diamonds" are used to show branching or decision points. In this diagram, eligibility for three other topics is determined by responses to the age question, so that question appears in a diamond. Some decisions may be based on a review of earlier entries rather than on responses to the last question. Thus, assuming that all names of houeshold members have been listed as a first step, the decision diamond following reentry point A requires the interviewer to look at the listing of persons and see if there are any for whom the information has not yet been obtained.

In most flow charts the sequence of the interview, as guided by the questionnaire, is shown as moving horizontally or downward, never upward. If there is any possible ambiguity as to the direction of the flow, arrows may be used, as illustrated with the line entering from the right side just above Q.3, sex. Question numbers are shown in this chart; this is recommended for flow charts prepared when a draft or final questionnaire already exists. The connecting lines in a flow chart should not cross each other; if this appears to be necessary, there is probably something

wrong with the structure of the chart or of the questionnaire itself.

Note that the topic education appears in two places on the diagram in Fig. 1. This is not generally desirable and could have been avoided by using a single exit from the age question for persons 5 and over and using a second decision diamond based on age after the set of education questions. The precise technique for handling this situation in the flow chart is not the main question, however. The important point is that by encountering this difficulty, we have been warned that there are moderately complex relationships between age and other topics on the questionnaire, and that these will have to be handled with some care to ensure that the necessary skip or branching instructions are clear and easily followed. A possible solution is shown in Fig. 2, which represents a rough draft of the questionnaire that was flow charted in Fig. 1. The format of this draft questionnaire is linear, i.e., the questionnaire has a separate line to record the information for each person, and the topics (some of which would later be put in question form) are shown in the column headings. The age groups to which the topics apply are shown by the group headings above the column headings.

Fig. 2. A Rough Draft of the Questionnaire that was Flow Charted in Figure 1

Line	All Persons			Persons 5 and over	Persons 14 and over		
No.	Name of person	Relation to head	Sex	Age	Education	Marital Status	Labor Force Status
1		Head					
2							
3						L	
:							
				İ			

3. The Use of Flow Charts in the Early Stages of Questionnaire Development

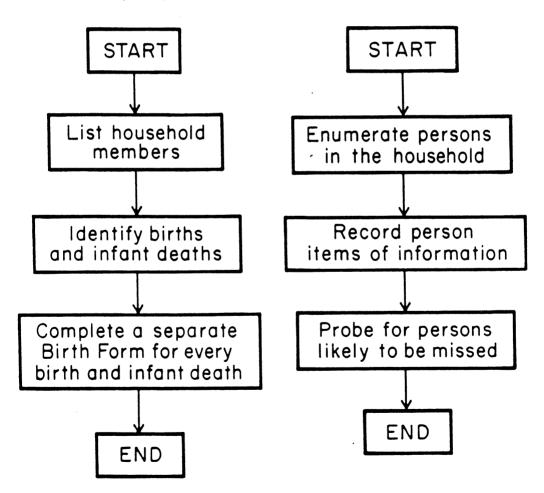
In the early stages of planning for a survey, before drafts of structured questionnaires have been prepared, flow charts can be useful in helping to decide how many different questionnaires or forms are needed and how the topics should be grouped and sequenced on each questionnaire. Some examples follow.

The first example is taken from Sirken (1972). Sirken uses flow charts to lay out the

structure of the interview and to identify the forms needed for a retrospective household natality survey in which data are to be collected on population by age and sex, births, and infant deaths. Figures 3, 4 and 5 are three in a series of flow charts used by Sirken for this purpose. Fig. 3 shows the overall structure of the interview in a household. It has already been decided at this point that a separate form will be used for births and infant deaths, since these are events which will not be associated

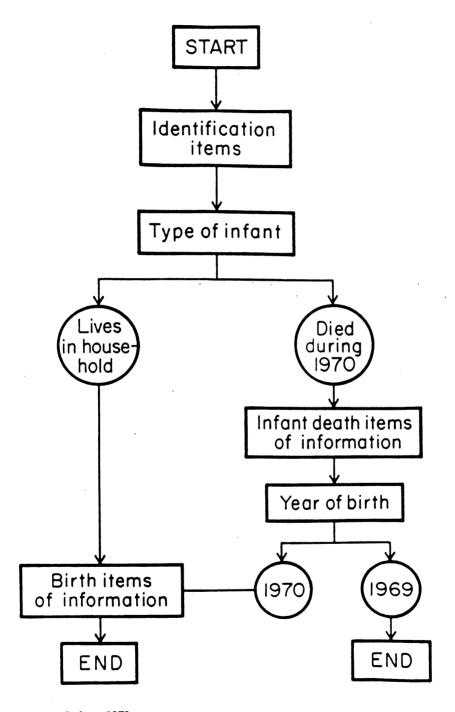
Fig. 3. General Structure of the Interview for a Household Natality Survey

Fig. 4. Flow Chart for Completion of the Household Listing Form



Source: Sirken, 1972 Source: Sirken, 1972.

Fig. 5. Flow Chart for one Version of the Birth Form



Source: Sirken, 1972

with every household. Fig. 4 shows the general structure of the household listing form. Fig. 5 is a flow chart of one version of the form for births and infant deaths. (In the manual, Sirken shows two different versions of this form, and a flow chart for each version.)

Sirken's flow charts shown here illustrate the logic for the interview process and the individual forms. One can imagine that the development of charts like these as an initial step would make it much easier to proceed with the drafting of the two types of questionnaires, and would substantially reduce the danger of omitting important items or establishing awkward groupings or sequences of items.

The reader may have noted that Sirken's flow charts do not completely follow the conventions presented in the previous section. Rectangles are used for starting and ending points as well as for groups of questions, whether or not followed by branching. Circles are used to show responses or conditions that lead to branching. Arrows are used throughout, although they are not strictly necessary. Nevertheless, these charts are clear and serve their purpose well, illustrating that the process is more important than the particular convention used.

A second example of a flow chart used at this stage of questionnaire development appears in Fig. 6 on the next page. This flow chart, taken from a U.S. Bureau of the Census (1979) case study manual used in training programs for population census planning, shows a summary flow chart of topics to be included in a population census. Like the hypothetical example in the preceding section, it groups topics according to the age groups for which they are appropriate. In addition, there is a second variable, sex, which serves as one of the eligibility criteria for the fertility items.

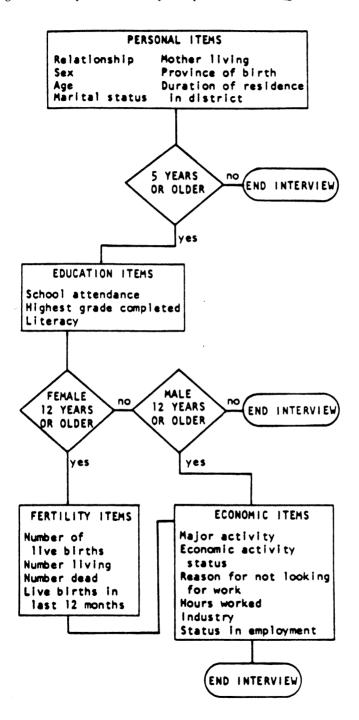
4. Use of Flow Charts in Understanding and Reviewing Questionnaires

When a draft of a structured questionnaries is available, a more detailed flow chart can be prepared showing individual questions or items and the branching patterns that occur within sets of questions. For the reviewer of a complex draft questionnaire, such a flow chart can be of great help in understanding its logic and structure and in spotting faulty or awkward sequences and groupings. If a flow chart is not available, the reviewer may want to prepare one, covering at least the more complex sections of the questionnaire. If this is done as a first step in the review, the reviewer will be much better prepared for a detailed evaluation of indivudual questions or items.

Similary, when a final version of a questionnaire is available, a more or less detailed flow chart of it can be of value to field and central office personnel who will be using the questionnaire in data collection and processing operations. A well-designed flow chart will give interviewers and field supervisors a broad view of the topics covered and how they interrelate, and will help them to understand the sequences to be followed for different categories of respondents: thus it should be a valuable tool for training and for manual reviews of completed questionnaires. The flow chart should also be useful to central office subject-matter and systems analysts who design the manual and computerized processing operations needed to produce the desired data from the completed questionnaires.

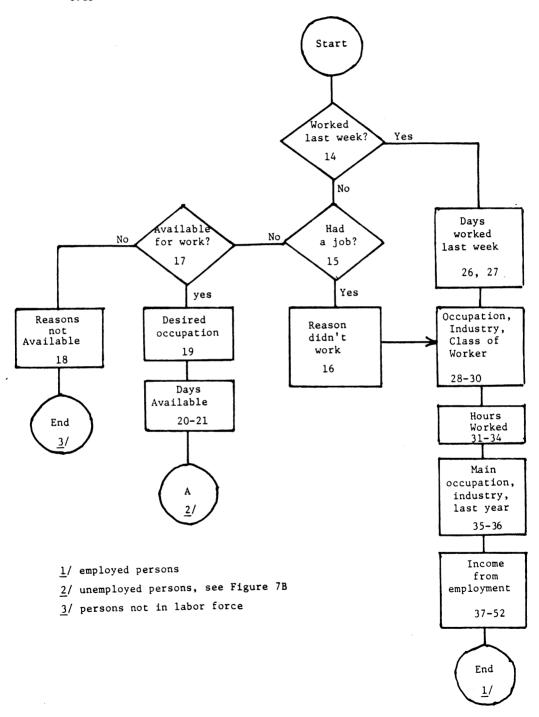
Fig. 7A is a flow chart of the labor force module from the questionnaire for the annual Labor Force Survey conducted by the National Statistical Office (NSO) of Thailand. This flow chart was adapted from one prepared by the NSO primarily for training purposes in connection with a new set of labor force questions introduced in Round 2 of the 1983 survey.

Fig. 6. A Simple Flow Chart for Population Census Questions



Source: U.S. Bureau of the Census, 1979

Fig. 7A. Flow Chart of Labor Force Questions from Thailand Labor Force Survey: Round 2, 1983



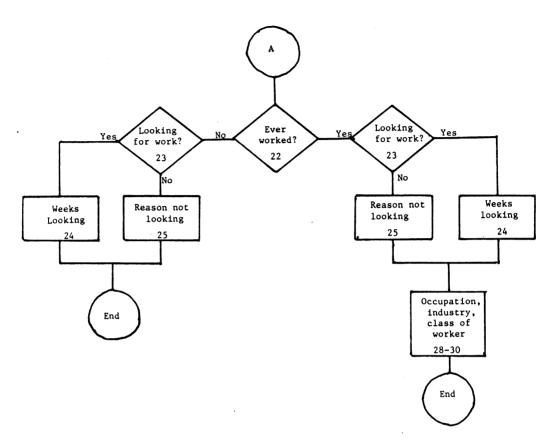


Fig. 7B. Continuation of Flow Chart for Thailand Labor Force Survey

Space and language problems preclude showing the actual questions represented by the flow chart. The primary purpose of this set of questions is to determine the labor force status of each person 11 years old and over in a sample household. Starting with question 14, a rather complicated set of branching instructions is followed until each person can be classified in one of three categories: employed, unemployed, and not in labor force. In addition, for persons in each category, appropriate information is obtained on occupation, industry, class of worker, hours worked, income from employment, reasons for not working or looking for work, etc.

Looking at the individual questions and skipping the instructions, that appear in the column headings of a questionnaire with a linear format (one person per line), it is difficult to visualize the relationships between the individual items and the three labor force categories. The chart, however, makes these relationships quite clear and indicates what additional items are to be asked for persons in each category.

While this flow chart was prepared primarily for use as a tool for understanding the structure of this complex set of labor force questions, one could also visualize it as a tool for review of a draft questionnaire with the objective of trying to simplify its rather complex structure. As one example of how this might work, note in the continuation under A for unemployed persons (Fig. 7B) that questions 23, 24, and 25 appear under both the yes and no branches of the "Ever worked?" question (22). This suggests that the sequence might be simplified by putting question 22 after questions 23 to 25, at which point a "no" answer would end the interview and a "yes" answer would branch to question 28. This possible revised sequence is shown in Fig. 8 on the following page. Its primary advantage is that interviewers no longer have to refer back to question 22 after completing the next three questions in order to determine where to go next.

Another potential problem that can be identified from the flow chart relates to the sequence of questions on occupation, industry and class of worker (questions 28 to 30), which appears on two of the three main branches in Fig. 7 those for employed and unemployed persons. For employed persons, other questions follow this set; for unemployed persons it is the final question. Making this clear necessitates a fairly complex instruction following question 30. No alternative will be suggested here: the intent is simply to illustrate how a detailed flow chart can be used as a diagnostic device to identify branching patterns that may cause problems in the interview. If the questionnaire is already in its final form, the diagnosis can identify questions or groups of questions requiring special attention when training interviewers and reviewing their work. If changes in the questionnaire are still possible, the flow chart diagnosis can help to identify the kinds of changes that might be desirable.

5. Use of Flow Charts for CATI Questionnaires

In a computer assisted telephone interviewing (CATI) system, there is no questionnaire in the conventional sense. The "questionnaire"

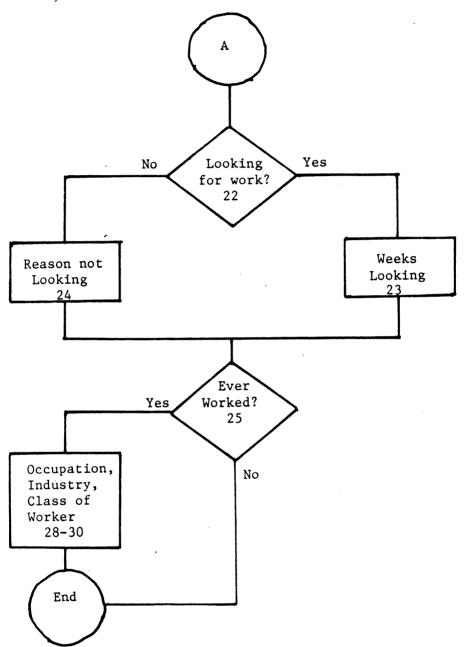
is a computer program which controls the display of individual questions on the interviewer's video display terminal and processes the responses keyed by the interviewer. In a sense, this interview program can create a unique questionnaire for each interview, including only those questions that apply in that interview and varying the wording of individual questions in appropriate ways.

A CATI system must have a language which allows the questionnaire designer to communicate a set of questions and edit specifications to the system. Once these materials have been entered in a language the system understands, it can then compile (using what is sometimes called a "questionnaire-writer" program) the program that actually controls the interviews.

For some CATI systems, the initial input may look very much like a conventional hardcopy questionnaire draft. Other systems, such as the Audits and Surveys CATI system (Roshwalb and Spector (1979)), use an interactive approach to input questionnaires into the system. In the Audits and Surveys system, the survey designer responds to questions generated on his or her video display by keying in questions, response categories, and identification of response categories from earlier questions that lead to the current question. The module includes edit features to ensure that there are no dangling response categories, i.e., categories for which the next question is not specified.

It is evident that flow charts can play an important part in the construction and use of CATI questionnaires; for an example see Groves et al. (1980). This should be especially true where the interactive approach to questionnaire construction is used. The survey designer might find it easier to respond to the questions put to him or her by the computer if he/she had, in addition to a simple list of questions and responses, a flow chart showing the selection and sequence of questions for various kinds of respondents. In addition, a

Fig. 8. Revised Sequence of Questions for Unemployed Persons in Thailand Labor Force Survey*



^{*} Some questions have been renumbered to fit the new sequence.

flow chart should be useful for interviewer training, especially in systems where nothing that looks reasonably similar to a conventional questionnaire is produced. When CATI procedures are used, it is quite feasible to use branching patterns that are substantially more complex than would be considered practical in traditional modes of interviewing. In such cases, it would be especially important for those who need to review the questionnaire and understand its structure to have a carefully drawn flow diagram.

6. Questionnaires That Use Flow Chart Features

Some survey research organizations incorporate selected features of flow charts directly into their questionnaires. Branching patterns based on response categories are indicated by arrows leading from each of the response categories to the next question or set of questions. To avoid possible confusion, responses and questions or groups of questions are enclosed in geometric figures. Rectangles are used most commonly; however, circles are sometimes used for response categories.

These techniques can be used in either interview or self-administered (i.e. mail) questionnaires. They are probably less common in the latter. Interviewers can be instructed as to the meaning of the particular conventions used. Once they understand the format, one would expect that it would be helpful to them in following the proper sequence of questions in each interview. For self-administered questionnaires, one is not generally in a position to train or instruct respondents; therefore the format should be a simple one that almost all respondents can be expected to understand and find helpful in completing the questionnaire.

Three examples are presented in this section. The first two are taken from interview questionnaires; the third is a short self-administered questionnaire. Fig. 9 is the marriage

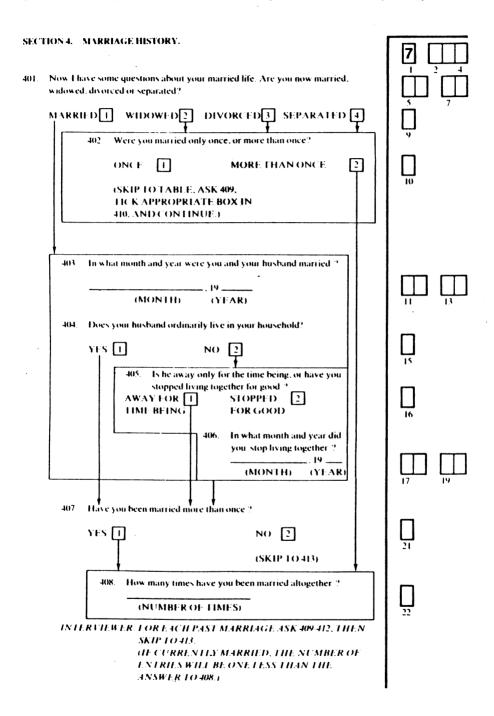
history section from the core questionnaire used in the World Fertility Survey (1975). Branching patterns are shown by arrows that proceed from response category codes in the small squares to rectangles containing the next question or group of questions or, in the case of question 407, to an unenclosed question. The table for former marriages at the right illustrates a method of using arrows to show branching in a questionnaire module with a linear format.

The second illustration is the first page of the section for recording information on employment of the household head, taken from the questionnaire for the 1984 Study of Family Economics conducted by the Survey Research Center, University of Michigan (Fig. 10). The form differs in some ways from that of the World Fertility Survey questionnaire. Both the code and description of each response category are enclosed in the same rectangle. Vertical arrows are used to direct the interviewer to the next question or to make a short skip; horizontal arrows lead to instructions for longer skips. For question C1 the rectangles for response categories 4 to 8 are enclosed in a larger rectangle to make it easier to show that all of these responses lead directly to question C2.

Survey organizations that conduct many surveys and use a permanent field staff usually try to be consistent in their use of the kinds of conventions illustrated in Fig. 9 and 10. Interviewers, once trained on and familiar with a particular format, would probably find it difficult to use a complicated questionnaire with a different set of conventions.

The third example is a mail questionnaire with an unusual design developed for use in a system of decentralized surveys to be conducted by French schools and universities to collect information on the current activites of their recent graduates (Fig. 11 on pp. 206–207 Affichard (1984)). The questionnaire uses a series of lines with arrows to guide the respon-

Fig. 9. A Section from the Core Questionnaire for the World Fertility Survey



Source: World Fertility Survey, 1975

FORMER MARRIAGES

NOOTHERS

HUSBAND

OTHER MALES

OTHER FEMALES

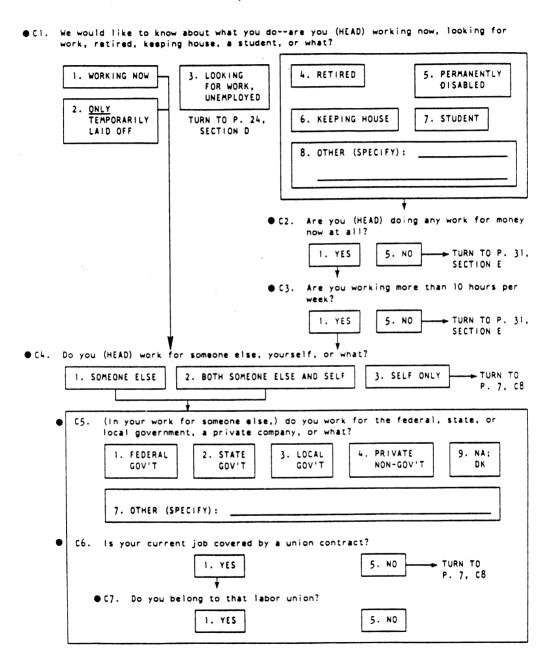
CHILDREN UNDER 10

8

	409. In what month and year did your (first, second =) marrage begin !	410. How did the marriage end?	411. IF DI- VORCE OR SEPA: RATION: In what month and year did you stop living together?	412. 1F DFATH: In what month and year did he die ?	
1	MTH	DEATH 1 DIVORCE 2 SEPARATION 3	MTH	MTH YR	23 25 27 28
2	MTH	DEATH 1 DIVORCE 2 SEPARATION 3	MTH	MTH YR	32 34 36 37
3	MTH	DEATH 1 DIVORCE 2 SEPARATION 3	MTH	MTH YR	41 43 45 46
4	MTH	DEATH 1 DIVORCE 2 SEPARATION 3	MTH	MTH YR	50 52 54 55
F	PRESENCE	VER: TICK APPRO OF OTHERS AT THAT APPLY):			

Fig. 10. A Section from the Questionnaire for the 1984 Study of Family Economics

SECTION C: EMPLOYMENT OF HEAD



Source: Survey Research Center, 1984

dent through one of three paths, depending on whether he or she is: (1) employed, (2) employed and in training or attending school part time, or (3) in some other category. Each of the paths first has an item intended to place the respondent in one of a set of activity subcategories. For paths (1) and (2) this item is followed by a module covering characteristics of employment and then a module on educational attainment. For path (3) the employment module is skipped.

The article in which this questionnaire is described states that a 1983 test in one region, involving several public and private educational institutions, produced a response of 63.4 percent from graduates to whom the questionnaires were sent. This response appears to be the result of an initial mailing plus one follow-up to nonrespondents.

7. Conclusions

The author has found flow charting to be a valuable tool for use in developing, reviewing and understanding questionnaires. The examples shown in this article are intended to encourage other survey researchers to try using flow charts in their work. The value of incorporating flow chart features in questionnaires does not appear to have been tested in controlled experiments; nevertheless, the examples given are easy to follow and it seems likely that the technique can be used successfully to minimize errors by interviewers or respondents in following complex skip instructions.

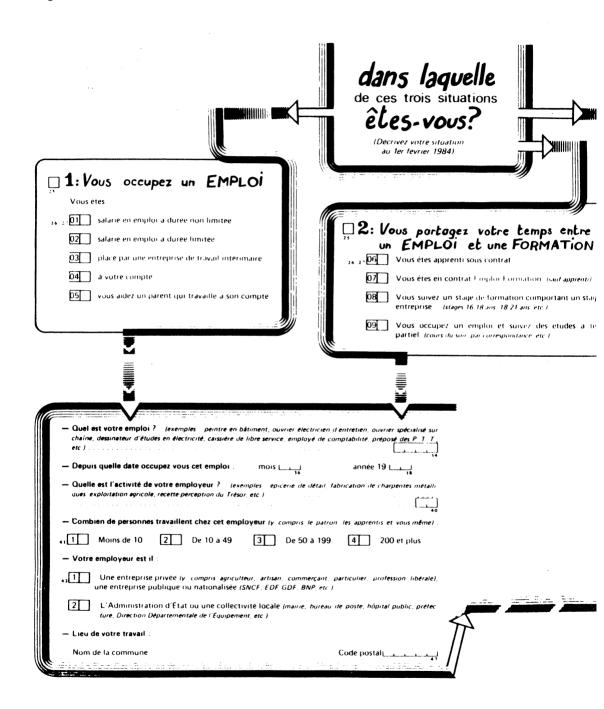
8. Acknowledgements

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Fig. 11. A Mail Questionnaire Using a Flow-Chart Format



	3: Vous êtes dans une autre SITUATION Vous etes entre deux missions d'interim Vous êtes au service national Vous ous vez un stage de formation ne comportant pas de stage en entreprise Vous poursuivez des études à temps plein dans un établis sement scolaire ou universitaire Lesquelles Vous suivez des études à temps partiel, des cours du soir ou par correspondance 16 Vous ne travaillez pas, ne poursuivez pas d'étude, ne cherchez pas d'emploi Auparavant, avez vous occupe un emploi de plus d'un mois ?
	— A quelle date êtes-vous entré en 6e . mois ∟, année 19 ∟, — Si vous n'êtes plus à l'école, au collège ou au lycée, à quelle date en êtes vous sorti : mois ∟, année 19 ∟,
	— Quels diplômes avez vous OBTENUS depuis le début de votre scolarité : BEPC, Brevet des collèges Certificat d'education professionnelle (CEP) Epreuves pratiques du BEP Brevet de technicien (BT) Epreuves pratiques du CAP Baccalauréat de technicien (BTn) Certificats acquis à l'issue de stage de formation Lesquels Autres diplomes Lesquels
indique	- Votre date de naissance jour mois mois manée 19 masculin 2 féminin - Le nom de la commune ou vous habitez Code postal commune ou vous habitez de renvoyer ce questiannaire dans l'enve loppe jointe

Source: Affichard, 1984