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Preface

This book contents the papers that were presented at the fifth international meeting of Blaise users, the International Blaise Users' Conference, IBUC'98. The conference was held in Lillehammer, Norway on 11-13 November 1998.

Unfortunally the collection of papers is not complete. The main topics at the conference as well as in the book are: Interviewers and other data collection issues, Editing and processing, Design, testing and documentation, Case-studies of Blaise surveys, Organisation and Users first look at Blaise 4 Windows. Two central presentations given at the conference, but not covered in the book are the presentation of Blaise 4 Windows by Statistics Netherlands and the presentation on Blaise and EU survey harmonisation, given by Pieter Everaers at Eurostat.

The scienticfic committee consists of: Vesa Kuusela (Finland), Gilles Luciani (France), Mark Pierzchala (USA), Asa Manning (USA), Lon Hofman (Netherlands), Jelke Betlehem (Netherlands), Tony Manners (UK) and Hilde Degerdal (Norway).
The program Committee for the conferencee consists of: Tony Manners (UK), Jørn Leipart and Hilde Degerdal (Statstics Norway).
Hilde Degerdal has collected the paper for this book.

Section A. Interviewers and other Data Collection Issues

Experience of the Norwegian CAI-system

Hilde Degerdal, Statistics Norway

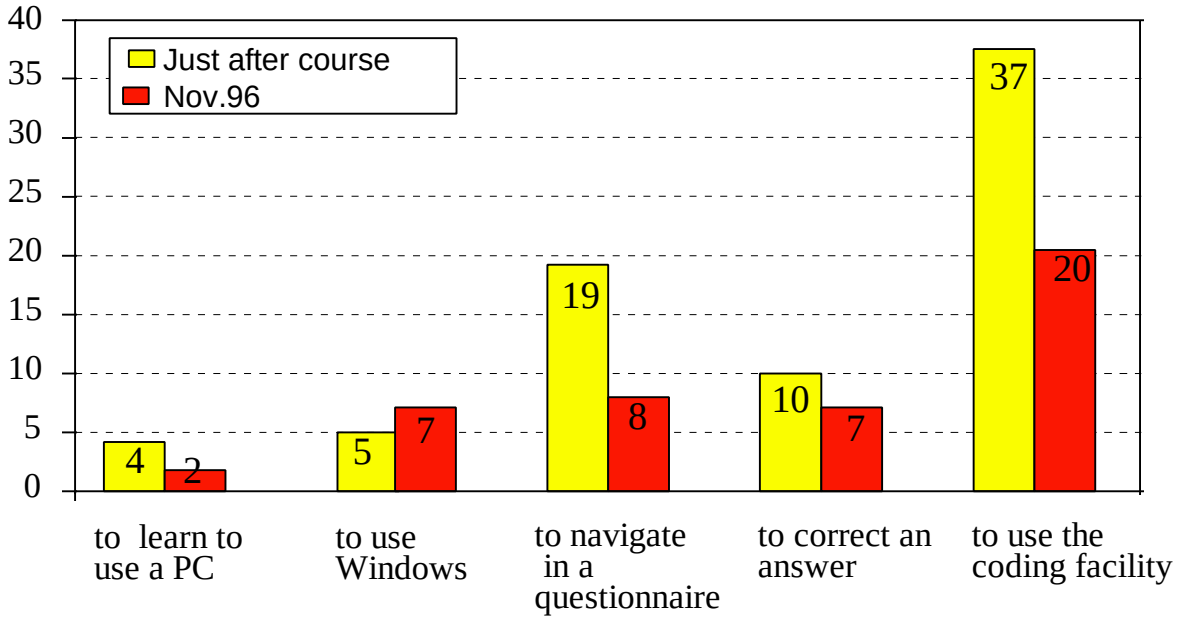
The Norwegian system of Computer Assisted Interviewing was implemented in 1995. Then it differed from most other solutions in two main ways. Our interviewers had laptops with a full Windows version on, and it also offers, a opportunity to send e-mail between the interviewers. The main concern of our solution was to use standard programs with slight modifications. We chose Windows because it seemed certain that Windows would become the computer environment in the future, and we thought that the interviewers could get familiar with this from the start. Giving them a full Windows version also gave them the opportunity to use the laptops as a computer, not only as an «interviewing machine». In this paper I will describe our experience of this.

Windows

To look back to 1995, of course we were worried about how to train 150 interviewers to use Windows. Our interviewerstaff consists of people in different age, 36% of them have no experience in use of computer at all. For the interviewers that already were trained as interviewers, we held separate 4 day's computer courses. They learn to know their laptops, they were trained in Windows, the mail and Blaise. We divided the courses into two parts, so that they had some training time home by themselves. In this period they had some exercises to do, and they got familiar with the equipment.

Even though 60 % of those who attended courses for interviewers in 1995-1996, had used Windows before, we gave them all the same training. We found it just to difficult test their skills.

Those who were trained in the two first years got a questionnaire to fill in a couple of weeks after the course. The data from this tells us that 5% find it difficult to use Windows. As a comparison 19% find it difficult to navigate in a Blaise questionnaire and 37% to use the coding facility. So just 5% finding it difficult to use Windows is quite surprising. In November 1996 we send a new questionnaire to the interviewers. Then we repeat some of the questions.



Obviously Windows is not the most difficult part. They all go through the windows training well. I think mostly because they find it interesting and fun.

The bars to the left tells us that not more then 4% find it difficult to learn to use the computer all together. After a while less then 2 % remembered that they found it difficult to learn. So to conclude about training, it was not at all as hard as we were afraid it could be.

In a questionnaire filled out by the interviewers in June this year, we asked if they use the laptop for other tasks than the interviewer work. Even though 57 % of the interviewers told that their household had an other computer as well, 66 % of the interviewers also use their interviewer laptops to other tasks than interviewing, mostly for games, 46 %. We do not equip the interviewers with printers, but some of them have bought it themselves. So also 15 % report that they use the laptops for writing.

All togheter the interviewers are happy about the Windows solution. Knowing Windows gives something that is becoming a part of common knowledge in society. Even though it costs something with one day's training on the courses and some hours of support, the conclusion must be that Windows was the right way to go for us. As I said it gives the interviewers a computer, not just an “interviewing machine” , it is more “fun” to use, that make it easier to learn, and they appreciate to get this kind of common knowledge, and of course we also hope that having experience in a Windows environment will make our interviewers better prepared for Blaise 4 Windows.

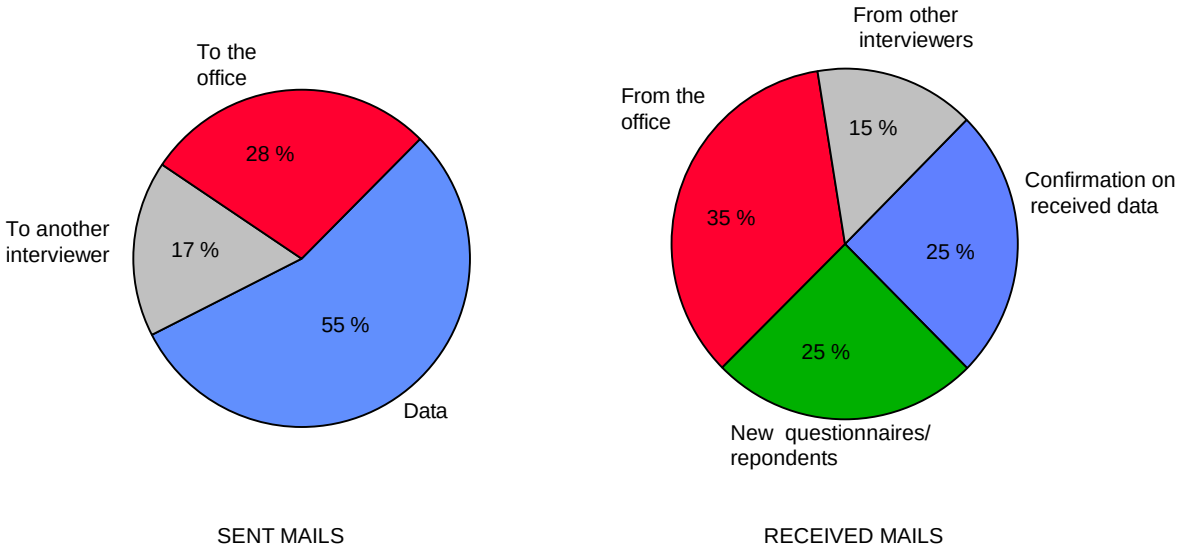
The Mailsystem

The communication part of our CAI-system is a slightly modified version of Microsoft Mail. The modifications consist of facilities to receive interview tasks at the laptops and to return interview data. These facilities work almost automatically. The regular functions of the MS Mail are not influenced by the modifications, so it is open for sending mails between all users of the system. It means between interviewers and the office, and also between one interviewers and another.

We are contented with this solution. E-mail is a convenient way to communicate. The mail system offers an efficient and cheap way to send messages and questions to the interviewers, and vice versa.

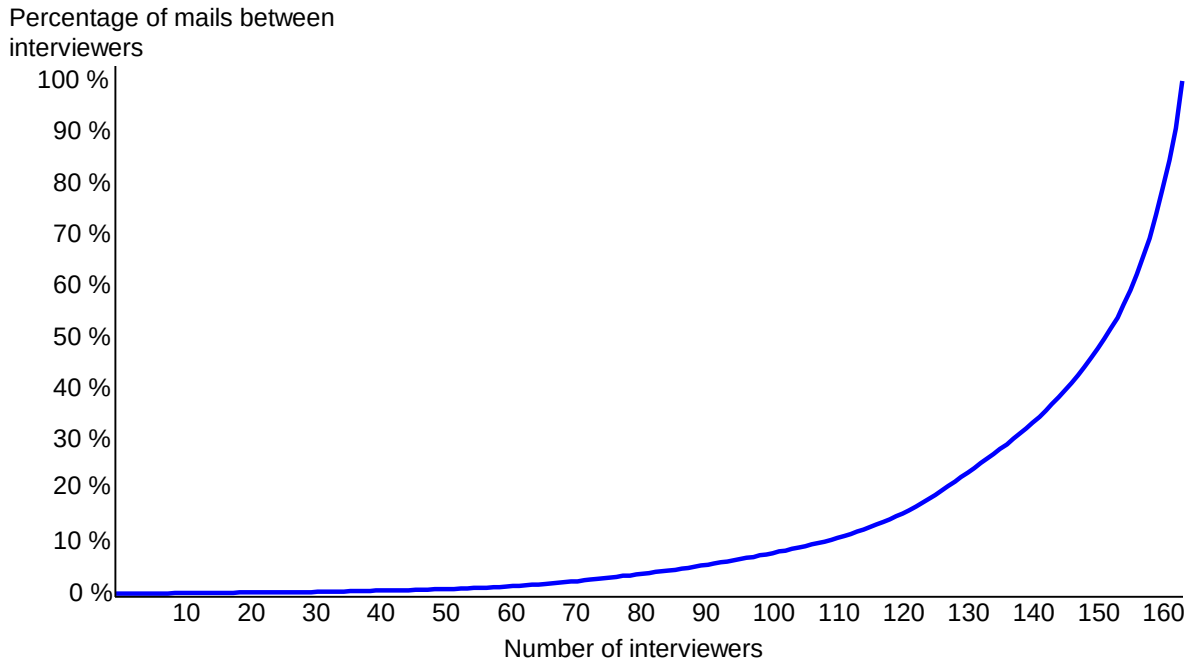
If we take a look at the logs for the remote mails for a period of 500 days, they show that most of the mails sent by interviewers are interview data, 55%. Some more than a quarter of the mails sent by the interviewers are addressed to the office, so the part of the mails addressed to another interviewer is 17%.

They receive in average some less than two mails each per day. Most of it is ordinary mails from the office, 35%. Receiving data at the office automatically produces a mail to the interviewers as a confirmation. Of course this it quite a large part of the mails, as well as new tasks and respondents.



A closer look to the mails sent from one interviewer to an other shows that during the period almost all of the interviewers had sent at least one mail to an other interviewer.

The frequency of use differs very much. One fourth had sent more than 150 mails to another interviewer. They have as you can see produced 80 % of the mails. The same size of part had sent less than 5 such mails.



To work from home as an interviewer is a lonely occupation, with very poor contact with colleagues. So in the questionnaire in June almost everybody said they prefer to have this opportunity to keep in touch, for example with people that they got to know on the courses, or that work in the same area.
Even though 97 % of the interviewers want the possibility, less then 2 % gave the answer that they use this way of contacting colleagues very often. Nearly 70 % said they never or seldom do. Those who send mails to other interviewers, usually send it to somebody they learned to know on the courses.

Of course the content in a mail from one interviewer to another is not known by us in the office. It can be a little worrying not to know what is going on out there. But often when they are mailing, they also send a copy to someone in the office. Some of the mails are just social talk, jokes, cake recipes and things like that, but sometimes also more useful topics like sharing experiences, giving hints, discussiongroups and so on. Mostly we find the mails harmless. But we also have got to know some cases of undesirable use of the mail system. From time to time you have interviewers that are not too happy about their working conditions When they start to discuss those matters by sending mails to all the interviewers, somebody wants to say they agree or disagree, and then it sort of "takes off". Most of the interviewers do not like that sort of public grumbling at all. And we certainly do not like it. But it is not easy to stop, because then they complain that we are not letting

them discuss matters in mails, that we ourselves have the possibility to discuss during the lunch breaks. But we do not feel that those few cases actually represent a problem.

The interviewers are not exactly paid for the time used for mailing. Even though our system of payment is based on hours used, time used for mailing and other administration tasks, has been paid as four hours work each month.

So to conclude about the experience of having a mailsystem that offer a possibility of mailing among the interviewers; it is something that the interviewers benefit of, they can keep in contact with colleagues, it gives a way of sharing experiences, discussions of working conditions, sometimes useful and sometimes not. And it does not cost much.

What interviewers think about Blaise III?

Vesa Kuusela
Statistics Finland

Introduction

In Statistics Finland (SF), Blaise III was introduced in May 1997 simultaneously with the new laptops. Previous laptops were not powerful enough for Blaise III instruments and therefore the conversion was not possible earlier. Blaise III applications replaced Blaise 2.x applications gradually so that all new questionnaires were written by Blaise III, and by the end of same year practically all old questionnaires were converted to the new platform. The conversion was carried out so that no visible changes were made to the user interface of interviewers' laptop (see Kuusela, 1995). Of course, some changes were necessary in the initiation of an interview but they were embedded in the shell software and they did not have an effect on the interviewers' daily routines.

Before Blaise III was implemented, the user interface of DEP was translated in Finish and the interface was adjusted both to Finish language (changing hot keys), and to the object-based CAPI information system of Statistics Finland, as far as it was possible. For instance, most of the items in the File menu were not needed anymore, because of the architecture of the information system.

In Blaise III there are many new functions, but basically interviewing by a Blaise III instrument does not differ much from a 2.x instrument. The major change is the interface of DEP, which in Blaise III is based on the drop-down menus and 'hot keys'. On the other hand, there are many minor changes, which have a direct effect on the interviewer's usual working routine.

Still, the nature and the extent of the changes in the data entry interface were considered to call for one-day interviewer training. The training included only the use of DEP menus and the new functions in DEP. Additionally trigram coding was included in the training because it was not applied earlier. In the same context, also the new coding procedure was taught.

It is self-evident that interviewers are experts in interviewing. However, it is not always clearly recognised that they are also experts in the use of survey software and their opinions should be an important factor in the design of the interface of the data entry software. In many organisations, lots of effort is put on improving the quality of surveys. The actual data collection is a critical part in the quality process that may lead to many kinds of errors and biases if disturbed some way. Interviewing as such is a delicate occasion, especially in a face-to-face interview, and the technical apparatus should be as transparent as possible so that it does not interfere with the interview. Otherwise, the benefits gained by CAI may be lost.

Despite the evident importance of the usability testing of interviewers' interface there appears to be no reports or studies on that. However, the user organisations have little or no possibilities to influence the functions or appearance or survey software. Yet, monitoring interviewers' feelings

and opinions is possible. In that purpose the interviewers of SF were asked about some features of the new software.

Study material

In June 1998, approximately one year after Blaise III was introduced, interviewers were asked about their experience and feelings of the new system. Nearly all interviewers (n=133) completed a questionnaire where they were asked how they use different DEP function and what they think of the new features. In the present study are included also the 15 new interviewers hired after the introduction of Blaise III and hence they had not use Blaise 2.x.

The longer-standing interviewers were mostly middle-aged women and most of them had four years experience with CAPI. The new interviewers were younger women and in their selection was applied the experiences on how the old interviewers had learned the use of the computer (see Kuusela, 1996). For instance, all the new interviewers were already familiar with computers and they had more education than the older interviewers. Comparing the answers of the new and the longer-standing interviewers had been interesting, but unfortunately the results based on 15cases are not very reliable.

Results

The CAPI information system in SF is based on object-based architecture (see Kuusela and Parviainen, 1997, Gray, 1995). That means that every interview is stored in a separate file and the shell module initiates the interview and gives DEP the sequence number of the sample point. The sequence number connects the form to the sample frame. If the sequence number in an opened form is changed, the link disappears and the probable consequence is that the case will end up as technical non-response.

DEP asks the primary key regardless whether it was given during the initiation or not, and touching any key (except enter) while the field is active will erase the entire field. Then, if the interviewer does not remember the (sometimes eight digits long) sequence number, the case will be lost. Also other organisations have faced the same problem (Sjodin, 1997). During the training the danger was brought up and stressed many times and interviewers were advised how to bypass it. However, occasionally accidents have happened. The interviewers' experiences were asked by the following question:

Question: The sequence number is shown every time during the initialisation of an interview and you must not change it. Have you ever changed it by accident?

Never	*88%*
Sometimes but rarely	*12%*

The result means that 12% of interviewers have sometimes accidentally changed the sequence number, but it is not clear how many interviews actually have been lost. Probably not a very large amount. On the other hand, the result shows that the danger is real and some cases will be lost even in the future unless the primary key field may be protected or hidden.

Selection of menu items

The interface of DEP, i.e. the menu system, is in close resemblance to many common and popular software and, of course, to Windows. Therefore it should be familiar to many people, especially to ADP professionals. However, interviewers are not ADP professionals. In fact, for most of them the laptop is the only computer and the survey software is the only application they use actively. Consequently, the menu system with its implications and its use was new to most interviewers.

Question: Many functions may be invoked either from the menu or by a 'hot key'. Which way do you use more often?

Mostly from menu	*24%*
Both ways	*38%*
Mostly by hot keys	*38%*

Question: In case you use the menu, do you select the item by arrow keys and enter or do you use the highlighted letter?

Mostly arrow keys	*63%*
Both ways	*22%*
Mostly the highlighted letter	*13%*
Don't know	*2%*

Question: In general, do you find inconvenient the use of menus?

Yes	*9%*
Don't know	*17%*
No	*74%*

The newly hired interviewers seemed to use more often hot keys whereas the more experienced interviewers more often turned to menus. Even when the new interviewers open a menu they select the item more often by a highlighted letter (i.e. hot key) while the old interviewers usually make the selection by the arrow keys.

In the average, the newly hired interviewers were more familiar with computers than the long-standing interviewers, although none had used CAI software before. That may partly explain the different behaviour of the two groups.

Effect of the screen layout

In SF, only the basic screen layout has been applied, so far. The only screen item that has been different from one questionnaire to another is the location of the horizontal line dividing the screen in two panes. Additionally, throughout each questionnaire only one layout has been applied; that is, separate questions do not have different layouts in a questionnaire. Consequently, sometimes long questions and/or long lists of answer categories are not shown completely. Usually this has been pointed out in the question text, but sometimes the author has forgotten to include the remark. Then, in the worst case, there is no way to notice that part of the question is missing.

Question: Long questions and/or long lists of answer categories are not shown completely on the screen and that has not been indicated every time. Have you faced problems due to that?

Never	*32%*
Sometimes but rarely	*61%*
Repeatedly	*7%*

Less than one third of the interviewers have not faced problems with long questions. Bearing in mind that even researches make mistakes, this feature of Blaise III is a potential source of serious errors. In some cases there has been doubts whether the cause of a curious distribution was a partly 'hidden' list of answer categories.

Question: Scrolling the text of the long questions and/or long lists of answer categories is possible by changing the active pane by pressing F6. Have you experienced it too complicated? Have you faced problems with that?

Never	*42%*
Sometimes but rarely	*56%*
Repeatedly	*2%*

The use of F6 to display the whole question text is appears convenient enough, but many interviewers have expressed that in Blaise 2.x this was handled in a better way. In Blaise III, this problem could be solved by different screen layouts, but their definition is so complicated that in the usually very tight time limits it is not possible to design them.

Question: The question text may be shown in a separate screen by pressing F9 and the screen may be enlarged by F5. Have you used this option?

Never	*41%*
Sometimes but very rarely	*52%*
Repeatedly	*7%*

Displaying the question text by the F9&F5 key combination is awkward and its applicability is even more restricted because of the fact that the interviewer cannot make any selection in it. Therefore few interviewers use it.

Question: In multiple choice questions answer categories may be selected by first pressing key F6 and then by arrow keys. Have you used this method?

Never	*1%*
Sometimes but very rarely	*10%*
Repeatedly	*89%*

The selection and marking the answers in a multiple choice questions by arrow keys suits well in the situation, because both presenting and answering this type of questions if different from the other questions types.

Interviewing with Blaise III

Three questions dealt with the interviewing practice with Blaise III, that is marking the answers, browsing forms and moving in a form.

Question: Have you faced problems with opening forms, interrupting interview or with closing forms?

None or very little	*88%*
Sometimes but not disturbingly	*11%*
A little, disturbing my work	*1%*

Question: Have you faced problems with marking answers or moving in forms?

None or very little	*71%*
Sometimes but not disturbingly	*24%*
A little, disturbing my work	*5%*

Question: Have you faced problems with browsing, checking or correcting completed interviews?

None or very little	*80%*
Sometimes but not disturbingly	*15%*
A little, disturbing my work	*5%*

The distributions are nearly the same as with Blaise 2.x that was asked a few years earlier. In general, it seems that no major problems exist. The reason is that this part of Blaise is very similar in both versions. This conclusion is strengthened by the fact that the new interviewers reported more often having faced problems.

Computer assisted coding

It is a common practice in many surveys of SF that interviewers code at least the occupation and community. Also some other answers are coded during the interview. For instance countries in the travel surveys. Previously, with Blaise 2, only the alphabetical coding was applied but in the connection with the change of Blaise version also trigram coding was introduced.

Technically the coding in Blaise III is different from the coding practice previous in earlier versions. Therefore, in the training, a considerable amount of time was used to teach the use and the possibilities of the new method.

Question: Along with the change of the Blaise version also the coding method was changed. Was the previous method better or worse than the new one?

Previous was better	*13%*
Don't know	*47%*
Previous was worse	*40%*

Question: Now we use two different coding methods, trigram coding and alphabetical coding. How do you experience the use these methods?

Trigram coding is easier	*13%*
No difference	*58%*
Alphabetical coding is easier	*27%*
Don't know	*2%*

It seems that there was some discomfort with the new coding method. Nearly half the interviewers could not say was the new method better or worse than the previous one. The reason may be the coding interface that is not very user-friendly.

Also interviewers' attitudes on the trigram coding was slightly diffuse, although theoretically it should be much better the alphabetical coding. Unfortunately interviewers were not asked to specify why some of them found the alphabetical coding easier than trigram coding.

Three quarters of the new interviewers found no difference between the methods whereas nearly 30% of the longer-standing interviewers found alphabetical coding easier.

General impression of Blaise III

In addition to the single features, the overall appearance of Blaise III is different from Blaise 2.x. For Instance, the wider possibilities to use colours gives many new possibilities for the designers and the colours make the looks of DEP more appealing. Consequently screens contain more information which is fairly easy to grasp. Also some additional new functions (e.g. for navigation) facilitate interviewers work. Some features interviewers cannot see because they affect the structure of a questionnaire, but they may make the forms functionally better, which on turn interviewers notice. This area of Blaise is difficult to cover with specific questions. It was hoped that the questions below cover this aspect:

Question: Generally speaking, what do you think of Blaise III compared with the previous version?

Blaise III is much better	*21%*
Blaise III is better	*69%*
Versions are equal	*9%*
Blaise III is worse	*1%*

Question: Have there been problems in the use of Blaise III?

Yes	*12%*
No	*88%*

The specified problems were diverse and diffuse. Most reported problems were caused by unstable or otherwise badly designed questionnaires, not directly by Blaise. Yet, some interviewers reported confusions with the use of the F6 key.

Interesting option in Blaise III is the inherent calculator but it was not clear would interviewers accept it.

Question: In DEP, there is also a calculator. Have you used it?

Yes	*11%*
No	*89%*

Judged by the first impression, which was not very enthusiastic, it was slightly a surprise that 11% of interviewers had really used the calculator. Probably its usage would by more frequent if copying the results to the form was easier.

Interestingly enough, the newly hired interviewers used the calculator more often.

Most of the major surveys carried out by SF are both in Finish and Swedish. When Blaise 2.x was in use this was solved by installing two surveys in the bilingual interviewers' laptops. The result was problematic in many ways and the possibility to use several languages in a single questionnaire was a major improvement. No one of the 15 bilingual interviewers regarded the old version better and only a few problems were reported. They were mainly caused by problems in switching the language in the middle of an interview in questionnaires, which included imputed question texts.

Discussion

Overall, Blaise III data entry module was accepted well by the interviewers and they considered it better than previous Blaise versions. Some considered Blaise III as a major improvement.

Some functions were not accepted as well. For instance, interviewers' opinions of the coding module were ambivalent. Probably the reason is the interface that is rigid and a little awkward. A feature that may be a source of errors is the screen that sometimes 'hides' part of the question text. Especially when part of the list of answer categories is neither shown nor indicated the danger is real.

As a final observation, we must remember that this study demonstrates only one aspect. Interviewers compared Blaise III to the previous version Blaise that they had used for many years. The results may have been different if interviewers were asked to compare Blaise to other CAI software or to some totally different software.

As noted earlier, data capture is a key element in improving the quality of surveys. One part of this is the technical apparatus they (have to) use. It should be as transparent as possible so that interviewer may concentrate on interviewing and not having to think the functions of the interface. In the development of data entry interfaces interviewers' opinions and usability testing is important.

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The Health Survey for England -- Preserving consistency over multiple data sources

Sven Sjödin,
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1. About the Survey

The Health Survey for England is sponsored by the Department of Health. It is a continuous survey conducted every year throughout the year. A new sample is issued every month. The monthly sample size for the 1998 survey is 1140 addresses. The survey started in 1991 and has been running continuously since 1993. The SCPR has conducted the survey since 1994 in collaboration with the University College of London.

The Health Survey for England is a household survey in the sense that most of the household members are eligible for interview. The current rules for eligibility allow for ten adults and two children aged two to fifteen. Each interview starts with a household section to collect household level information. The interviewer will then select up to four respondents for each session of **concurrent interviewing** to gather person level information. The person level data is partly collected through self-completion booklets.

Concurrent interviewing is a method for increasing the efficiency of household surveys. The sessions are built up by a succession of tables that enables the interviewer to progress with more than one respondent at a time. The tables are short sequences of questions which are repeated for each respondent in the session.

On agreement, each respondent will be visited by a nurse. The nurse records various measurements and collects samples. The samples are then sent to a laboratory for analysis. Each sample and measurement requires a signed consent by the respondent. Because of the nature of the survey, there is an obligation to report the medical results to the respondents, who are also asked for their consent for the results to be given to their GP (physician).

Apart from the laptops and any paper documents, the interviewers and the nurses carry a fair amount of equipment. The interviewers measure height and weight using stadiometers and electronic scales. The nurses have Dinamaps for blood pressure readings; various tape measures; equipment for taking blood samples; and straws for saliva samples.

2. Problems in the Old Days

It is of vital importance for the quality of the survey that the **person identifiers** in each part of the data are consistent and correct. The Health Survey for England has an unusual number of data sources that contribute to the final data set. In addition to the main and nurse interviews, there are self-completion booklets, consent booklets and various laboratory results.

This has always generated a vast effort to detect and solve inconsistencies, even once the main questionnaires were converted to CAPI in 1995. All the information passed between the

interviewer and the nurse was on paper. An error could occur each time a serial number or a person number was transcribed. The only measure used to counter this problem was the use of the respondent's date of birth to supplement these internal identifiers. For this reason the date of birth was typically recorded seven or eight times per respondent. Every time an inconsistency was discovered a very complex set of rules was applied to resolve it.

The data collected with the nurse paper questionnaire also required a substantial amount of editing. As every measurement is repeated at least twice there was an obvious risk of error from misreading the equipment, recording the wrong value or recording a value in the wrong place.

3. Nurses going CAPI

The 1998 survey faced the need to minimise the risk of such inconsistencies. By converting the Nurse Questionnaire to CAPI (Blaise III), we expected a significant reduction in the editing work. Most of the edit checks on consistency can be implemented in the data model. There are also the usual advantages of CAPI compared to paper such as enforcing the route; control over value ranges; and the possibility of recording the time spent interviewing. All the nurses are now equipped with laptops and modems and are given the appropriate training.

Converting the Nurse Questionnaire to CAPI reduces the risk of internal inconsistencies. But it does not actually address the problem of inconsistencies between these different sources of data. A mechanism is required to pass data from the interviewer to the nurse in a way that is more reliable than paper forms. The situation is very similar to that of a panel survey. To control for consistency, data from previous waves are sent out for each new wave.

Ideally, the nurse starts each case with all the relevant information already present. The nurse interview is then coupled to the main interview so that, by definition, the identity of each person is consistent between the two.

We set out to achieve this by amending our in-office system. From the incoming main interviews, we generate data records which are made available to the nurses to download on to their laptops. The Survey Management system writes out ASCII
format data files and the appropriate laptop identifier. The ASCII files are then converted to Blaise files for the nurse data model to use as external information.

This **transfer information** is a household level record with a set of person level sub-records. It stores the name, age, sex and date of birth of each eligible household member. For children aged two to fifteen, it also holds information about the parents in the household.

4. Time Is Of The Essence

Our initial approach was to let the transfer mechanism drive the allocation of cases to nurses. That is, the nurses were only given access to the cases that had passed through the in-office system. This hard coupling guaranteed the consistency between the main and the nurse interview.

However, there were are three main time factors that ruled out this approach:

- First, unlike a panel survey wave, the nurse appointment can come very soon after the main interview. An interviewer can make an appointment for the nurse for the very same day. The transfer system needs at least one day to turn over the data and it is not operative over weekends. Therefore, the nurses have to be able to conduct the interview before they receive the transfer information. In such cases the nurse has to enter the corresponding data from a paper form. This means that the nurses have to be issued with the same set of sampled addresses as the interviewers. A further implication is the fact that the nurse data model has to be a household level, rather than a person level, questionnaire.

- Second, the interviewer may not finish the whole household in one single appointment. Some households can take weeks to complete. Our standard procedure is to book in cases only if they have a final outcome code. For the Health Survey for England we also need to be able to process incomplete households in case there is information to pass on to the nurse. The nurse data model will then have information about the composition of eligible respondents, but will not know whether or not each respondent agrees to see the nurse.

- Third, the same time factor applies to these residual respondents as apply to the whole household. The nurse has to be able to start the interview before the final **nurse agreement** data are available. In fact, we also have to allow the nurse to interview respondents who explicitly rejected seeing her at the time of the main interview. They may well have since changed their minds.

The nurse agreement data are sent out as a separate data file which is shared by all the nurses. The reason for this is the fact that, while the transfer information is produced just once per household and requires some manual intervention, the agreement data may arrive at the office at a later date. The initial nurse agreement data, usually blank, are created for each eligible person at the same time as the transfer information. It is then updated automatically each time new respondents have completed the main interview. This information is needed to warn the nurse if she tries to interview a person who has rejected, or yet agreed, to see her.

Whenever a nurse opens a household or selects a person within a household and the data model cannot find the corresponding transfer record or agreement data, the nurse has to override a warning to continue. These warnings are implemented as conditional fields. On the household level, the field also gives the nurse a way of screening out addresses that do not require a nurse visit.

5. The Nurse Data Model

All these complications make the nurse data model very elaborate. It has to cater for several different scenarios. It has to record whether or not it is started in a manual or automatic mode, i.e. if the transfer information is present on opening the case. It also has to recognise when this information subsequently arrives. If the household was opened in a manual mode and the transfer information has since become available it has to cross check the information entered by the nurse against the transfer information.

The table below explains the different scenarios and their implications for the nurse data model. Each scenario starts with the state of the household when the transfer information is downloaded to the laptop.

Table 1. Scenarios and Nurse Data Model Behaviour

1	The household is not yet opened.	The ideal situation. The transfer information is read and stored. No checking is required.
2	The nurse has entered all the household information	The transfer information is read and checked against the nurse entries. These entries are not altered, but any inconsistent person level records are marked out. If so, the nurse is prompted to correct inconsistent person numbers.
3	The nurse has entered some of the household information.	The transfer information is read and checked against the nurse entries as above. Any residual person level records are added to the household composition data.

The nurse data model consists of a short household level section and up to twelve Nurse Schedules for person level data, declared as parallel blocks. The household section contains a household grid which is either filled in by the nurse (manual mode) or automatically from the external data file. It also handles the hidden mode control fields. Each Nurse Schedule is made active in the main RULES section if the nurse has manually entered a nurse agreement code or the person record is found in the nurse agreement external file.

There are also up to twelve parallel drug coding schedules. This is where the nurses code the recorded drug names according to the British National Formulary (BNF) coding scheme. Declared as parallel, they are independent of the RULES section of the Nurse Schedule and can be completed at any point during the interview.

6. Challenges Along The Way

Any Blaise III data model that depends on heavy initial computations and checking has to be programmed with great caution. For the nurse data model it is essential that each step of calculations is completed before the next step can start. The Blaise III **dynamic checking** mechanism, however, will try to execute all the RULES sections in what seems like a simultaneous manner unless it is stopped by appropriate conditions. It has taken a great deal of experimentation to find these conditions.

The most time consuming parts of the Blaise programming were:

- The section in the main questionnaire in which the interviewer selects respondents for sessions of concurrent interviewing; and

- The initial control structures of the nurse data model.

In both cases the difficulties arose out of the need to find ways of stopping the dynamic checking mechanism from setting vital control variables before the previous calculations and interviewer inputs are properly validated.

Both interviewers and nurses can be expected to need more than one appointment to complete each household. This has special implications for the design of the data model. For example, the key routing fields have to be safeguarded so that keying errors on re-entry will not take whole sections of the questionnaire off the route.

A different kind of technical challenge was posed by the nurse agreement data. If it fails to update on the nurse laptops there is a risk that nurses cannot proceed with some person level interviews. The corresponding file on the network is almost constantly in use as it is downloaded each time a laptop connects to the office. This sometimes leaves very short time slots during which it can be updated. It has taken some time both to recognise and to solve this problem.

7. The Future

Although the data has not yet been edited, we believe that the current setup will greatly reduce inconsistencies within the nurse interview data and between the main data and the nurse data, thereby reducing the editing effort.

Looking into the future, are there any ways to further improve the consistency between the multiple sources of data in the survey?

One obvious possibility relates to the self-completion section of the main questionnaire. By turning this into a Computer Assisted Self Interviewing (CASI) section we could eliminate the risk of attaching an incorrect person identifier to the data. This has been considered, but rejected, as it would defy the principle of concurrent interviewing if the laptop has to be passed between respondents and other respondents have to wait for their turn.

It is possible that we can improve the in-office system or use other electronic channels, e.g. the Internet or email, to speed up the data transfer from interviewers to nurses. If this can be achieved we can also return to the ideal situation of only issuing nurses with the appropriate cases and at the more suitable person level.

At the more futuristic end of the scale, we could minimise the risk of inconsistently labelled paper components once laptops have built in label printers or printers are small enough to be portable. This would also work for nurse sample labelling.

In an ever growing market of home medical kits, e.g. pregnancy tests and DNA tests, it is not impossible that one day we will be able to supply the nurses with blood and saliva analysis equipment, thereby cutting out the laboratories altogether.

For the 1999 survey there will be yet more challenges. Part of the sample will be aimed at ethnic minorities with interviews conducted in languages other than English. We have opted for a script based system, rather than the Blaise languages facility, as six extra languages using non-Latin characters would pose too much of a maintenance problem.

To improve the probability of finding ethnic minority households we will apply a method called **focussed enumeration**. For selected sample points the interviewers will call at the three addresses to the right of and the three addresses to the left of the sampled address in search of ethnic minority households.

A related issue is that, for multi-ethnic households, we will need to be able to re-allocate half finished interviews to interviewers with the appropriate language skills.

8. Summary

The Health Survey for England is a survey with multiple sources of data. Apart from the main and the nurse questionnaires, there are self-completion booklets, consent booklets and various laboratory results. There is a clear risk of inconsistent case and person identifiers between the data sources. The task of identifying and solving these inconsistencies is very time consuming and prone to error.

For the survey year 1998 we have tried to reduce the risk of such inconsistencies with special attention paid to the coupling of the main and the nurse interviews. By converting the nurse questionnaire to CAPI and implementing an automatic transfer of data from the main interview to the nurse laptop, we have sought to reduce the risk of inconsistencies both within the nurse interview and between the main interview and the nurse interview.

Some time related factors complicate the system. First, the first nurse visit can follow very shortly after the main household interview, before the household composition data can be transferred. Second, the nurse may want to interview respondents before downloading any information on whether or not they agree to see her.

These factors make the nurse data model very complex. It has to cope with different scenarios depending on the state of the interview when the external data is transferred. It also has to cater for the Blaise III dynamic checking mechanism as this will prematurely try to assign values to vital control fields unless stopped by appropriate conditions.

The way forward is to quicken the transfer of data from the main interview to the nurse. Ideally, this should also drive the allocation of person level cases to the nurses. The risk of inconsistencies can never be completely eliminated, but there are some possible technical developments that may further reduce them.

Exploring Data Collection by the Internet

Hans Wings and Ger Snijkers, Statistics Netherlands

Summary: *At Statistics Netherlands a pilot has been carried out to investigate the possibilities of e-mail for business data collection. The intention of Statistics Netherlands is to use e-mail and the Internet for data collection on a larger scale within a couple of years. These modern modes should be integrated within a mixed mode design of data collection (together with more traditional modes like paper and fax) where sampled businesses may decide on which mode to respond in. The purpose of this pilot was to find out how many and what kinds of businesses were willing to participate. Thus, an empirically based policy with regard to this modern mode can be developed. In this paper the design, response and characteristics of the participating businesses will be described.*

An aspect that is of great importance with regard to the usage of the Internet for data collection on a larger scale is a well designed measuring instrument, that looks 'fancy' on the screen and is easy to use. For Statistics Netherlands efficient data processing is an important issue. Blaise on the Internet (ConQuest) will deal with these aspects.

Keywords: *Data collection, E-mail, Internet, Blaise.*

1 Introduction

Within Statistics Netherlands Electronic Data Interchange (EDI) has been a research topic for several years now. The purpose of EDI is to collect business data that are stored in administration databases (primary EDI) or in client administration databases (secondary EDI). However, not all data collected by Statistics Netherlands can be gathered by means of EDI, simply because not all business data are available in electronic databases. Thus, these data have to be collected in other ways, e.g. with use of self-administered forms. Up till now these forms have been paper forms. An additional research program has been initiated to develop ways of data collection by means of the Internet or e-mail: the EDI-Sheets program. The ultimate goal of this program is to collect the bulk of business data electronically within a couple of years.

To collect data in electronic ways several aspects of the survey have to be adapted, like the measuring instruments (electronic forms in e.g. ASCII or HTML), the data collection process (like the transmission of forms) and the data processing. Within the EDI-Sheets program a pilot has been carried out to investigate the possibilities of data collection by e-mail[1]. The design of the pilot may be qualified as self-administered paper-and-pencil interviewing with 'paper-and-pencil' replaced by a computer screen and a keyboard. In section 2 this pilot will be described. In this section also several comments and suggestions for improvements with regard to the design of the pilot will be described. As it turns out, these issues typically deal with Computer Assisted Interviewing (CAI). A CAI-tool is Blaise. In section 3 attention will be given to a new development regarding Blaise: Blaise on the Internet. In section 4 some conclusions are drawn.

[1] This pilot has been carried out in co-operation with the subject matter department.

2 Data collection by e-mail: a pilot

2.1 Design and response

To investigate the possibilities of data collection by e-mail, a pilot study was carried out. In this pilot the questionnaire of the monthly Survey on Short Term Economical Indicators was sent to businesses by e-mail. The survey-questionnaire is a short paper form with 10 questions: 9 closed questions and 1 open question. The survey describes the development of commissions in the manufacturing industry.

In order to get the e-mail addresses, respondents were asked to participate in an e-mail test for the month of April 1998. The recruitment was done in February. Two questions were added to the February form: one on willingness to participate and one on the e-mail address. This resulted in 205 respondents who filled in their e-mail address (from a sample of 1547 businesses, of which 1355 returned a completed form). Almost all respondents who filled in their e-mail address were willing to participate in the e-mail test: 192 (94%). This means that, in relation to the total sample of businesses that received a paper form (1547), about 12% were willing to participate in the test. These e-mail addresses were registered in the survey database.

The 13 respondents who filled in their e-mail address but who were not willing to participate were re-contacted by phone. They replied that they had no intentions to participate. Also 30 non-respondents with regard to the e-mail test were re-contacted by phone. Most of them replied that they simply did not have an e-mail address (24 non-respondents). A small number said that the business had an e-mail address, but that they could not use it (5), or that they did not know how to use it (1).

At the start of the test in April the recruited respondents received a letter to announce the forthcoming form by e-mail. The letter also included the registered e-mail address, in order to check this address. As a result, about 25 respondents replied with a corrected address. At the beginning of the fieldwork again about 25 e-mail addresses appeared to be incorrect. Most of these addresses could be changed. However, 9 addresses could not be corrected, so these respondents could not be reached by e-mail. Altogether, 51 of the registered e-mail addresses (27%) were incorrect. There are several reasons for this:

- addresses had been written down incorrectly by a respondent;
- addresses had changed;
- addresses had been entered incorrectly into the survey database by Statistics Netherlands employees who were not familiar with the conventions of e-mail addresses (data entry error), like the use of '@' and dots;

Editing of the e-mail addresses in the survey database turned out to be a very time-consuming process. Eventually, 183 e-mail addresses were used to receive the electronic form by e-mail.

The electronic form transmitted was an ASCII form (a simple text file), that can be completed by use of any text editor. At the start of the pilot some experiments were done using an HTML and a Blaise form. However, for several reasons it was decided to use an ASCII form:

- an ASCII form is hardware and software independent;
- an ASCII form is a small file, so a limited amount of data has to be transmitted to the respondent;
- for both the sender and the receiver the system (sending and receiving an e-mail) is simple and hence considered to be user friendly.

Consequently, the received e-mails had to be entered with Blaise to make the answers available in an electronic form.

A Blaise form was not discussed as an alternative because additional software (e.g. the Blaise Data Entry Program) had to be transmitted to the respondent. Another alternative considered was the use of an HTML-form that can be filled in with an Internet browser like Microsoft Internet Explorer or Netscape Navigator. However, at that moment there was no software and hardware infrastructure available to handle the received forms.

The forms were sent to the respondents over a period of three days: 40 forms on Wednesday 22 April, 75 forms on 23 April, and 77 on 24 April. With this way of transmission, the burden of having to deal with a lot of problems at the same time was reduced. Thus, respondents who called or mailed with a problem could be helped almost instantaneously. From that moment on two members of the project group were standing by to help respondents. It turned out that not many respondents needed help. Only about 5 respondents called for help: they could not read or open the message.

On Wednesday 6 May a reminder was sent to the respondents by e-mail, followed by a reminder by fax (a paper form) on Tuesday 12 May. All together, 157 completed forms were returned by e-mail. This is a response rate of 86%. The response figures for number of days within a form was returned, are listed in table 1. Within two weeks a little more than 60 percent of the respondents had returned a form; within three weeks 80% had responded. Some delay in completing and returning the form may be caused by the fact that at the time of transmission some respondents did not yet have the data to fill in the form. After we received a completed form a receipt of delivery was sent to the respondent by e-mail.

Table 1. Response after … number of days

Returned (within number of days)	Responded				*Total*	Response	
	Spontaneously	After reminder		No		Numbers	Rates (%)
		e-mail	Fax				
1	32	-	-	-	32	32	11
2 -< 8	41	-	-	-	41	73	40
8 -< 15	23	16	-	-	39	112	61
15 -< 22	1	26	8	-	35	147	80
22 -< 30	0	0	10	-	10	157	86
Non-response	-	-	-	26	26		
Total	97	42	18	26	183		

During the preparations of the pilot extensive attention was given to safety measures to be taken, like encryption of the completed and returned forms. Several encryption programs have been investigated with regard to the following criteria:

- the program must have a limited size (since it had to be mailed to the respondent);
- it must be hardware independent;
- it must be easy to use by the respondent;
- the encryption must be hard to decode.

None of the programs seemed to fit all criteria. So, it was decided to add a disclaimer to the questionnaire, referring to the risks of data transmission by e-mail. But, for those who would like to encrypt the completed form, this possibility was offered. To do this, they had to call one of the members of the project group who would tell them what to do. Only 6 respondents called to ask for encryption.

2.2 Analysis of participating businesses and respondents

In order to analyse the pilot with regard to the participating businesses and respondents, 11 extra questions on background variables were added to the survey questionnaire:

1? The first two additional questions asked for comments and suggestions for improvement by the respondent (thus offering the respondent a way to express his feelings about the test).

2? Then two questions followed on the time needed to complete the survey questionnaire and the number of persons involved.

3? Followed by two questions on the computer organisation of the business and two questions on the use of the Internet: business and personal.
(Other business characters, like the activity code and business size -the number of employees-, were already known from the Business register.)

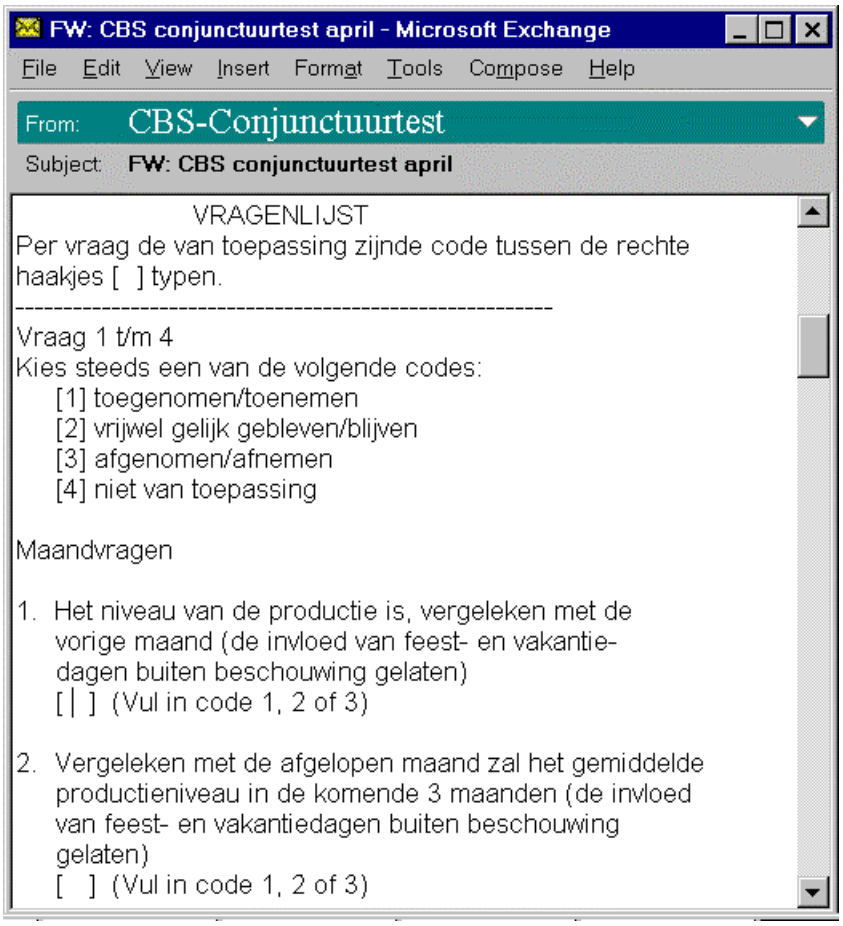
4? And at the end three questions on personal characteristics (gender, age and education level) were asked.

Ad 1. As for the comments and suggestions about 40 respondents reacted with about 60 suggestions in total. Regarding the comments, the following may be concluded in either positive (+) or negative (–) way:

+ The respondent regards the use of e-mail to transmit questionnaires as a positive development.
+ There were only a few technical problems reported. About 5% of the respondents reported a technical problem. These problems concerned not being able to read or open the message. Therefore, we may conclude that the respondents who have an e-mail address know how to use it.
+ No surprising technical problems were reported. Therefore, we regard the use of e-mail to be a reliable mode for data collection, with data quality comparable to the traditional paper mode.
– The electronic form (see figure 1) should be improved. 28 Comments and suggestions concerned the performance and the presentation of the ASCII form, including:
  - scrolling and the use of the cursor keys were considered annoying;
  - answering a question neither positions the cursor on the next question automatically nor places the next question on the screen;
  - answering a question changes the layout of the text (e.g. text moves on the screen);
  - answer possibilities were not adjacent to the question.

  However, these comments were expected beforehand, since we ourselves had these comments, based on the experiments we had done at the start of the pilot. Although, with the use of ASCII these properties (except for the last one) were inevitable, still it was decided to choose ASCII (as discussed in section 2.1).

Figure 1. The ASCII form on the computer screen (as presented by Microsoft Exchange)



It turned out that the safety measures taken (encryption) were considered relatively unimportant. It seems that respondents are not aware of the privacy risks that are involved in the use of the Internet.

Ad 2. The average time needed to complete the survey questionnaire (with exclusion of the additional questions) was 9.5 minutes, about one minute longer than for the paper form[2]. The difference in time may be explained by the new system (extra time needed for opening and reading the form) and the properties of the ASCII form as mentioned before. It is expected that this difference will disappear with repeated e-mail measurement. The average number of people involved was 1.25.

Ad 3. The participating businesses may be characterised as follows:

- In the sample only industrial business were included.
- Relatively more larger businesses participated in the test than smaller businesses (see table 2). This effect is significant. The figures in table 2 show that 32% of the largest businesses (with more than 500 employees) was willing to participate in the test, while for the smallest businesses this was about 7%.
- The businesses that participated are businesses with a modern computer organisation (see table 3): they have an internal computer network, use Windows, and are connected to the Internet for browsing.

[2] This question was also printed on the paper form, since it is policy of Statistics Netherlands to measure (and reduce) the interview burden for businesses.

Table 2. Number of businesses for willingness to participate and number of employees

Number of employees	Willingness to participate				Total
1	Yes		No		1
1	Number	Row-%	Number	Row-%	1
10 -< 20	10	6.7	140	93.3	150
20 -< 50	32	8.1	361	91.9	393
50 -< 100	30	8.9	308	91.1	338
100 -< 200	41	13.3	268	86.7	309
200 -< 500	38	16.6	191	83.4	229
≥ 500	41	32.0	87	67.0	128
Total	192	12.4	1355	87.6	1547

Table 3. Computer-organisation of the businesses

A. Internal computer network	Operating system				Total
	Windows			Other system	
	3/3.11	95/NT	*)		
Yes	23	84	30	2	139
No	0	9	5	0	14
Don't know	0	0	0	1	1
Missing	0	0	1	2	3
B. Connected to the Internet (for browsing)					
Yes	14	83	30	2	129
No	9	8	5	1	23
Missing	0	2	1	2	5
Total	23	93	36	5	157

*) Windows version is missing

Ad 4. The respondent (who participated in the e-mail test) may be characterised as a highly educated man, between 30 and 50, who is computer minded. 91% of the respondents is male, with an average age of 39 years. The average age of the female respondents is 33. (See table 4 -age and education level- and table 5 -use of the Internet).

Table 4. Age and education of the responding employee

Age	Highest education level					*Total*
	Lbo [1], mavo [2]	Mbo [3], havo [4], vwo [5]	Hbo [6]	University	Missing	
21 -< 25	0	3	2	0	0	5
25 -< 30	0	2	13	2	0	17
30 -< 35	2	8	15	12	0	37
35 -< 40	0	3	16	7	0	26
40 -< 45	0	5	6	3	0	14
45 -< 50	0	6	11	1	0	18
50 -< 55	1	10	7	4	0	22
55 -< 60	0	3	2	1	1	7
Missing	0	1	0	0	10	11
Total	3	41	72	30	11	157

Average age of the male respondents (139): 39 years
Average age of the female respondents (13): 33 years
1? lbo: lower vocational education
2? mavo: advanced elementary education
3? mbo: intermediate vocational education
4? havo:secondary education
5? vwo: secondary education
6? hbo:higher vocational education

Table 5. Use of Internet: business and personal

Business Internet-use	Personal Internet-use			Total
	Yes	No	Missing	
Yes	69	23	1	93
No, but there is a connection	15	20	1	36
No, there is no connection	4	19	0	23
Missing	1	0	4	5
Total	89	62	6	157

2.3 Internal evaluation of the pilot

Also internally the pilot has been evaluated. Apart from the conclusions already mentioned in the last section, the following main aspects may be concluded, both positively (+) and negatively (–):

+ The pilot resulted in a lot of information, on response rates, the scope for using e-mail for data-collection, the perception of the respondents with regard to e-mail and the electronic questionnaire, the number of technical problems.
+ E-mail is considered a reliable mode for data collection.
– Not much attention was given to the processing of the collected data. This meant that the completed e-mail forms were printed out and the data were entered into the survey database manually. As for the pilot this was no problem, but for a monthly production process this has to be automated.

Despite the fact that many respondent reactions concerned the ASCII form (as expected), we consider the choice for a simple design the right one. Thus, the data collection procedures and the technological aspects

were simple. In this way, e-mail seems an additional tool for data collection. E-mail can be used for the transmission of simple questionnaires in a mixed mode design (in which the respondent decides on the mode for responding, like paper, fax, e-mail, etc.).

However, data collection by the Internet has to be explored more fully.

3 Blaise on the Internet

3.1 Developing an interviewing tool for the Internet

As stated in section 2.2 and 2.3, still some issues (as carried out in the pilot) have to be improved to get a design for data collection by the Internet that satisfies both: the respondents (with respect to entering data in electronic forms) and Statistics Netherlands (with respect to the data collection procedures and data processing). CAI tools (Computer Assisted Interviewing) typically solve such issues. Alternative modern electronic forms and ways to collect the data have to be developed e.g. HTML-forms; Excel spreadsheets, or online filling in of an electronic form. The latter is discussed here.

Statistics Netherlands has used the Blaise system to conduct surveys for years. From this point of view it is obvious to develop an interviewing tool for the Internet based on the Blaise system. The effort to develop such a tool is limited to developing a front-end tool, which will replace the Data Entry Program of the Blaise system in an Internet environment. In fact, this CAWI tool (Computer Assisted Web Interviewing) is nothing less than an alternative input tool beside the already existing CAI tools. To develop such a tool Statistics Netherlands has started a project called ConQuest (Processing *Quest*ionnaires at your Internet *Con*sole).

3.2 Objectives of ConQuest

Eventually, ConQuest should become a tool, which covers the complete functionality of the current Data Entry Program of Blaise. For the short term the objectives are less ambitious: develop an interviewing tool for the Internet which can be incorporated in the current statistical process and which covers a wide range of simple questionnaires. Then, in successive versions the tool will be extended with more Blaise features. In the following sections the architecture of the ConQuest System is explained. We emphasise on the considerations, which are the basis of some important design decisions.

3.3 Architecture of ConQuest

While designing an interviewing tool for the Internet we have to take into account two software solutions: on the one hand a software component which presents the questionnaire to the respondent and on the other hand a software program at the Internet server which processes the transmitted data.

3.3.1 The presentation of the questionnaire

The presentation software

When choosing software for the presentation of the questionnaire it is important to take into account the diversity of environments respondents might use. All kinds of computer platforms are possible. It is obvious we don't want a software solution, which depends on the computer infrastructure of the respondent. However, we also don't want the respondent to meet certain hardware requirements or to install additional software. Investigating the possible technical solutions, the use of an Internet browser seems to be the most obvious choice:

- On almost all main stream computer platforms some kind of Internet browser is available or will be soon;

- Browsers are part of the standard software installed when connecting to the Internet and can be obtained free of charge.
- HTML, the language that defines the content of a page in a browser, offers sufficient elements to present a questionnaire on the screen.

Choosing Internet browsers as the client software raises the question of which browsers should be supported by the system. Several studies indicate that supporting Microsoft Internet Explorer 3.x and higher and Netscape Navigator 3.x and higher will cover 80 - 90% of the browsers, which are used by the Internet population at the current time.

The questionnaire logic

The questionnaire logic consists of the routing instructions and the consistency checks as defined in the Blaise data model. Not only rules defined in a data model can be complex and large, but also the mechanism to evaluate this rules is very complex and hence a large piece of software. If we want to execute this questionnaire logic at the computer of the respondent we have to transmit the rules information and the software component that handles the rules to that respondent. Technically this is possible with Java applets. However, the amount of data to transmit to the respondent is considered to be too large. Several seconds waiting time in an interview situation is not acceptable. Consequently, the ConQuest System executes the questionnaire logic at the server.

To restrict the amount of transmitted data and the frequency of server requests the ConQuest System executes the range check of a field in the browser itself. This is realised with JavaScript, a simple programming language that can be executed by the browser. The range check of a classification field in the browser implies that the complete classification of that field has to be transmitted to the browser. But, a classification may be very large and in addition a classification field is usually answered through a classification dialog. As stated before, we want to avoid transmitting large amounts of bytes to the browser. Hence the ConQuest System does not support classification fields for the time being.

Executing the questionnaire logic at the server and the intrinsic possibilities of HTML to describe the contents of a browser page imply that the ConQuest System presents one question per HTML-page only. The content of a browser page defined with HTML is static and can't be changed, so it is not possible to visualise for example a change in the routing of the questionnaire in a HTML-page which contains more than one question.

Because the functionality of Internet browsers will evolve and the transmission speed will increase as a consequence of the available bandwidth on the Internet, most of the above mentioned constraints will become invalid. It is evident: in future versions of ConQuest parts of the questionnaire logic will shift from the server to the browser.

3.3.2 The server software

Considering the IT-infrastructure at Statistics Netherlands, the server software of the ConQuest System is developed for a Microsoft NT server with Microsoft IIS (Internet Information Services). Amongst other things an important advantage is the scalability of the system. The number of concurrent users of ConQuest depends on sufficient hardware resources only. The server software makes use of several components, which we will discuss briefly.

The ConQuest Dep Manager

The ConQuest Dep Manager contains the application logic. It handles the active interview sessions, redirects all received browser requests to the appropriate interview sessions, stores answers in the Blaise database and executes the questionnaire logic of an interview session. It is the intermediate between the presentation of the questionnaire and the Blaise database.

The data storage

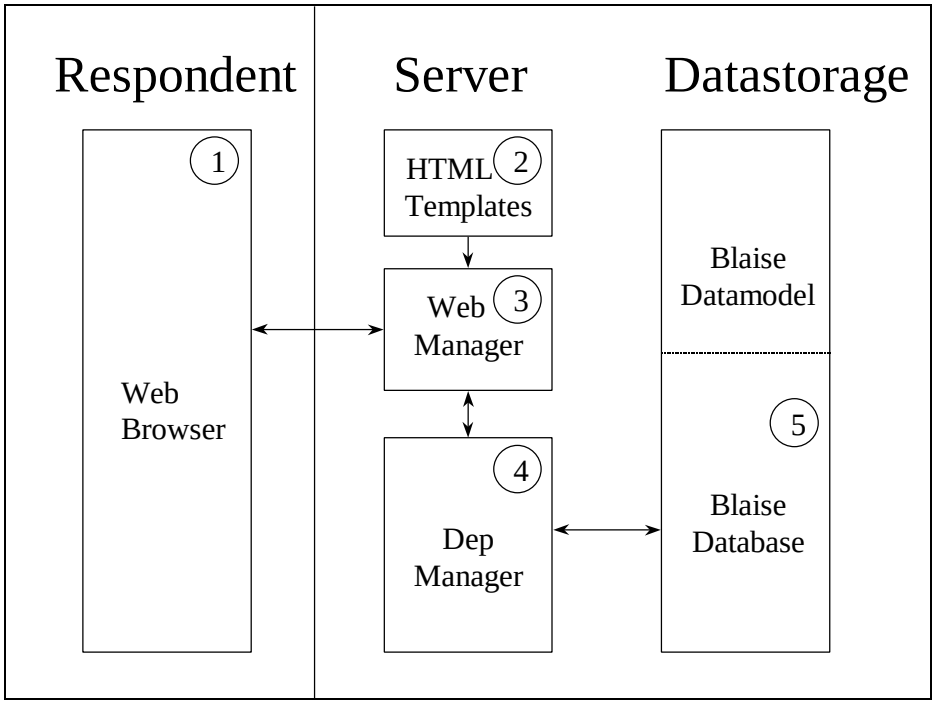
The data is stored in a Blaise database, so all Blaise tools can use the data collected with ConQuest instantaneously.

The ConQuest Web Manager

The ConQuest Web Manager contains a set of HTML-templates (comparable with templates in for example Microsoft Word). The HTML-templates define for example the base layout of an HTML page to

present a question. The layout of the HTML-pages resembles the default layout of the Windows version of Blaise as much as possible. Depending on the current state of the interview, such as ‘ask the next question’, the ConQuest Web Manager takes the appropriate HTML-template and completes it to a final HTML-page, which will be transmitted to the browser.

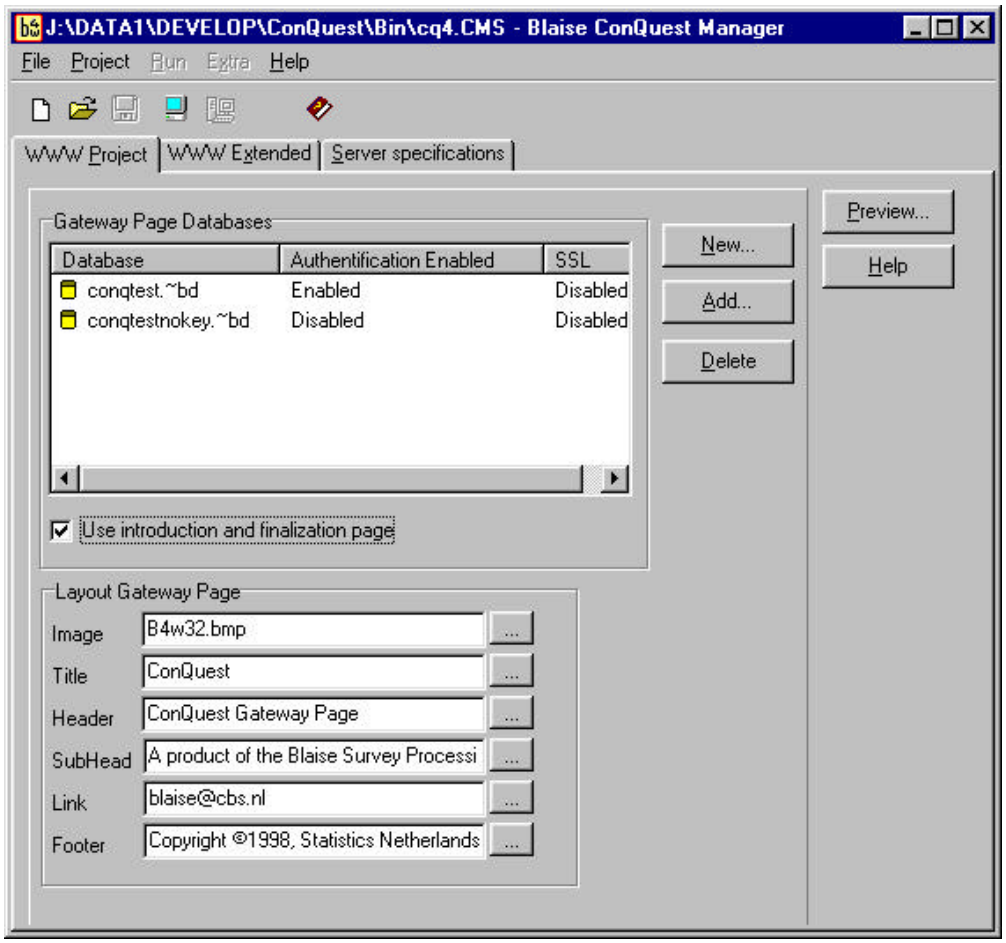
Figure 2. Summary of the architecture of the ConQuest System



3.3.3 The ConQuest System Manager

Besides the already mentioned parts ConQuest provides a tool called the ConQuest System Manager (figure 3). This tool is used to install a Blaise database on the Internet server and to change the settings of the ConQuest system.

Figure 3. The ConQuest System Manager [3]



3.4 Execution of an interview with ConQuest

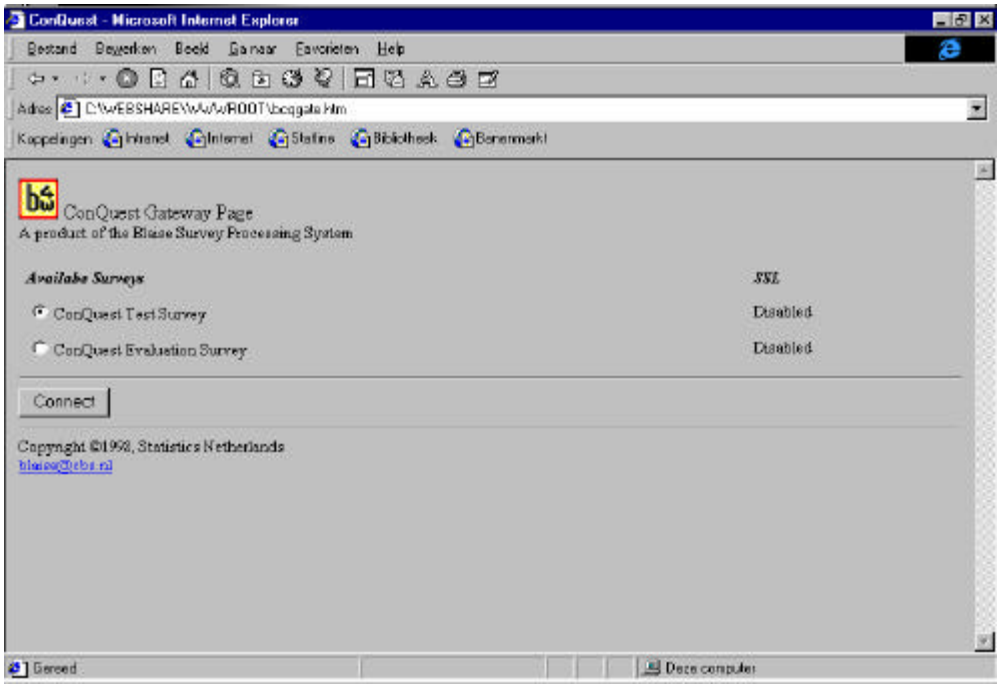
In this section we describe the execution of an interview briefly. Referred components of the ConQuest System are identified with the corresponding numbers in figure 2.

3.4.1 The gateway page

A respondent gets access to a questionnaire through a so-called gateway page (figure 4). The gateway page shows a list of available questionnaires. With the ConQuest System Manager (figure 3) the layout of this gateway page can be changed according to the preferences of the statistical organisation. To get access to a questionnaire a respondent needs to know the location of the gateway page at the server. Hence, distributing of questionnaires is limited to distributing a URL (Uniform Resource Locator) which describes the location of the gateway page.

[3] The shown user interfaces in this paper are not necessarily the interfaces of the final version of the ConQuest System.

Figure 4. Example of a Gateway Page



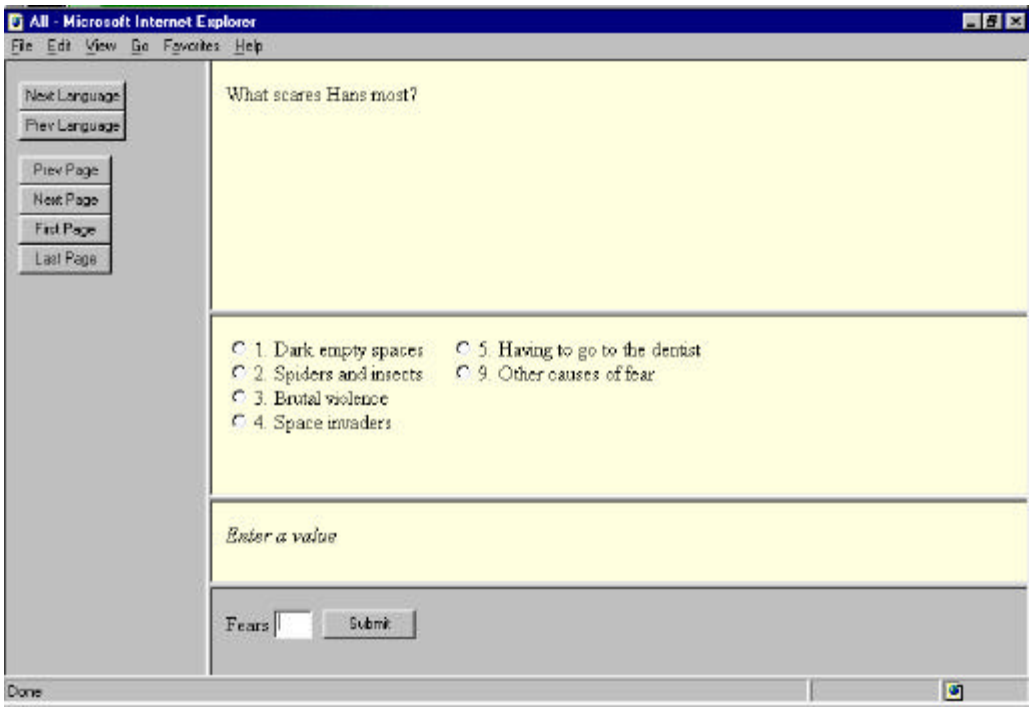
3.4.2 The interview session

The respondent chooses a questionnaire on the gateway page and submits this choice to the server. This initialises an interview session at the server. At the server the ConQuest Dep Manager (4) computes the first question to be asked according to the Blaise data model of this particular questionnaire. Then the ConQuest Web Manager (3) chooses the appropriate HTML template (2), completes this template to an HTML page for this question (figure 5) and transmits this page back the to the Web browser (1) of the respondent. This first question starts the interview.

3.4.3 Answering a question

After an answer has been filled in the respondent submits the content of the HTML-form back to the server. The Dep Manager (4) assigns the answer to the correct interview session, stores the answer in the matching Blaise form, activates the Blaise rules and computes the next state of the interview. According to this state the whole cycle is repeated again: complete the appropriate HTML-template to an HTML-page and transmit it to the browser. If the last question of the interview has been answered the Dep Manager (4) stores the Blaise form in the Blaise database (5).

Figure 5. Example of an enumerated field



3.5 Supported Blaise functionality of ConQuest

As stated before the first version of ConQuest will support a subset of the Blaise DEP functionality only. In this section we will summarise this subset.

3.5.1 Functional limitations

- The first version of ConQuest supports all Blaise defined field types except the classification type. Classification fields are usually answered through a classification dialogue, which can't be implemented with standard HTML or JavaScript yet.
- ConQuest does not support the usage of external files through a lookup dialogue. As for the classification dialogue, the lookup dialogue can not be implemented with HTML and JavaScript.
- ConQuest does not support alien routers. Because the client is assumed to be platform independent the current implementation of alien routers through DLLs can't be used with the Conquest system.

3.5.2 Different look and feel

Because the Internet environment differs from the Windows environment it is not possible to achieve the look and feel of the Dep of Blaise for Windows exactly. ConQuest tries to come as close to the look and feel of the Windows Dep as possible. Some differences are:

- answering an open question: the open question is not answered in a separate so-called modal window but through a so-called textarea-control on the HTML-page;
- layout of a Blaise page: the layout information of the Blaise datamodel is not used, but a standard layout is used only.

4 Conclusions

The e-mail test resulted in a lot of information. Both respondents and the project group at Statistics

Netherlands consider e-mail (with an ASCII form) to be a reliable mode for data collection, with few technical problems and data quality that seems comparable to the paper mode. For the businesses that participated in the pilot, response rate was high (86%). Based on these results, the department responsible for the Survey on Short Term Economical Indicators has decided to use e-mail for data collection on a permanent basis, along with the traditional paper form. But, as we have seen, several aspects need to be improved.

With the use of Blaise on the Internet the presentation and the performance of the questionnaire (automated routing, range checks), the data collection procedures and the data processing (data entry) will be modernised. When Blaise on the Internet is operational, another pilot project will be started to extend the different ways of electronic data collection for businesses further.

However, as we have seen, the scope for using e-mail in the manufacturing industries still is limited. Data collection by e-mail on a larger scale does not seem possible yet. All together, about 12% of the sampled businesses were willing to participate in the pilot. From these businesses, relatively more larger businesses were willing to participate than smaller businesses: 7% of the businesses with 10 to 20 employees, up to 30% of the businesses with more than 500 employees. Most of these businesses that participated, have a modern computer organisation with an internal computer network and a connection to the Internet.

But, access to the Internet and the use of e-mail is rapidly increasing. So, to be ready for the future, data collection by e-mail and the Internet should be explored now. Modern and traditional modes (like e-mail, the Internet, paper and fax) can be integrated in a mixed mode design in which sampled businesses decide on the way to respond. Thus, a respondent friendly system of data collection may be established.

Section B. Editing and Processing

The Models4 System: Simplifying data management in Blaise 4 Windows

Boris Allan, Westat (USA)

Summary

The Models System for Blaise III[4] performed the following actions:

1. The data model was split into component data models (`.BLA` files), where each of the component data models was equivalent to an ASCIIRELATIONAL file. A batch file was created to drive the remaining steps.
2. Each data model produced as a result of the previous step was then prepared to create meta information (`.~MI`) files.
3. A chosen Cameleon translator was then applied to each meta information file.

We were able to take large data models, and produce SAS macro descriptions for the whole model, where each SAS macro corresponded to an ASCIIRELATIONAL file. The SAS macros were created by a special translator `SASMACRO.CIF`.

With the release of Blaise 4 Windows, some of the command-line parameters for Manipula and Cameleon changed slightly, and batch files did not seem to fit well with a Windows environment. I decided, therefore, to change the models methodology to incorporate these new features, which included an improved Cameleon interpreter. The Models4 System follows a different sequence of actions:

1. The data model is split into component data models (`.BLA` files), where each of the component data models is equivalent to an AsciiRelational file (the new version uses improvements in the Blaise 4 Cameleon interpreter). At the same time, a reference file is written (`.REF`), where each record in the reference file has the name of a component data model and its folder.
2. Each record in the reference file designates a data model to be prepared to create a meta information (`.~MI`) file.
3. Each record in the reference file also, therefore, designates the meta information file to which a chosen Cameleon translator is applied.

One consequence of this new approach is that it is possible to construct a reference file containing a list of files (without the `.BLA` extension), prepare the named files, then apply the same Cameleon translator to all these files (see *The elements of Models4*).

The background to Models4

At Westat, we often have to deal with very large instruments where we cannot write or read a file with records that contain all the fields for an instrument. We have to divide the fields into manageable chunks corresponding to blocks, and those chunks are AsciiRelational[5] files. As an example, one "very large" study has a data model with over 166 different AsciiRelational files and a meta information (`~MI`) file greater than 3.5 MB.

---

[4] *Automatic generation of data descriptions for ASCIIRELATIONAL files*, International Blaise User Group Newsletter, July 1998.

[5] I try to distinguish between MSDOS and Windows versions of (say) files by using all `UPPERCASE` for MSDOS and `MixedCase` for Windows.

Because of the work involved in managing this amount of information, we had to find a way of making the task less labour-intensive. For example, for the data model with 166 different files, the file produced by the Blaise 4 Cameleon translator `AsciiRel.CIF` has 8060 lines. Developing a Manipula setup to write AsciiRelational files is a simple task (one need only use the Wizard) and the fact that the Manipula setup might take a long time to write the files is unimportant. I, for one, can easily find other things to do whilst that is happening — usually involving food.

We needed an equivalent of the Manipula Wizard to produce data models that were equivalent to the formats of the AsciiRelational files. These formats are implicit in the output of `AsciiRel.CIF` but have to be made explicit, because all the data models are in one file and cannot be prepared until the file is edited, and each data model copied to a separate file. Once we have these separate files, we have to prepare each data model.

If you think of the amount of work involved in splitting a file into 166 data models, and preparing those 166 models, then you can see why automation sung sweetly. For many of our studies, Models4 is the only way we can conveniently manage the conversion of Blaise data into other forms for analyses.

The development of Models4

In the days of Blaise III, the original task was resolved by basing a Cameleon translator on the Blaise III `ASCIIREL.CIF` translator, with certain modifications. Called `BLKMODEL.CIF`, the translator had to overcome certain limitations in the Blaise III `CAMELEON.EXE` interpreter:

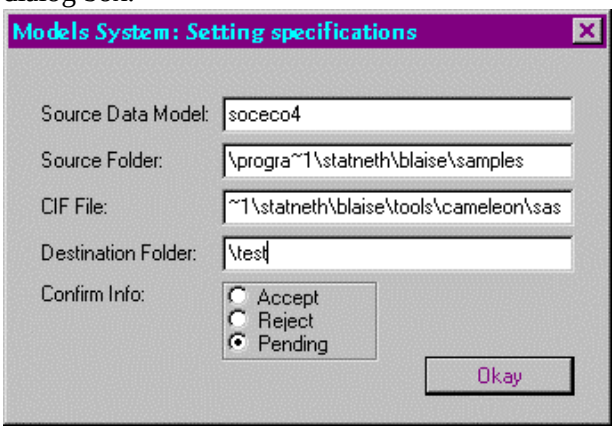
- One limitation was structural, in that you could not declare arrays of variables in the `[VAR ...]` section, and it was difficult to keep track of repeated types .
- Only types and embedded blocks at the top level were specified in the data model corresponding to Block 1 (the original data model). For data models corresponding to other blocks, type definitions (and similar) had to be copied from the top-level definitions.
- In a `TYPESLOOP ... ENDTYPESLOOP`, the only types tracked were types that had been defined at the level of the block, not types for the whole data model. Looping through types at the data model level did not include types defined at lower levels. `BLKMODEL.CIF` had to take a field at the block level, and search through the tree structure for enclosing blocks, until the top level was reached, to find the corresponding type definition (a reverse recursion). As each field had to be treated separately, and there was no central repository of types, type definitions were repeated.

  Another program, a Manipula setup called `CLEANTYP.MAN`, was used to remove duplicate definitions.
- `ASCIIREL.CIF` did not deal with classifications, and so a procedure to regenerate a classification was implemented.
- To deal with embedded blocks, and *nested* embedded blocks, special procedures had to be implemented for blocks at lower levels, if those blocks had fields referring to embedded blocks in their declarations.
- Various problems arose with the way the `CAMELEON.EXE` interpreter treated Blaise III `SET OF` declarations, and with the way the interpreter treated the Cameleon meta data distinction between `DEFINEDTYPENAME` and `PREVIOUSTYPENAME`.

Some of these points have been addressed in the Blaise 4 `Cameleon.EXE` interpreter, and the Blaise 4 `AsciiRel.CIF` translator. The Blaise 4 equivalent of my `BLKMODEL.CIF` is my `Create_Models.CIF`, which is based on ideas in the Blaise 4 `AsciiRel.CIF` translator, with some modifications. Generally speaking, Blaise 4 Cameleon is much more reliable than before, and this is reflected in the improved quality of the supplied sample translators.

Models_System.MAN: The interface to Models4

To start the Models4 System, you use the Maniplus setup `Models_System.MAN`, with the following dialog box:



In this example dialog:

- The Source Data Model is `SocEco4,` a variant of the `SocEco` sample provided with Blaise 4 — the listing of `SocEco4.BLA` is in the Appendix.
- The Source Folder is `\progra~1\statneth\blaise\samples` (using the abbreviation `progra~1` for `"program files"` because the version with the space can cause confusion for some of the Blaise 4 system command-line interpreters).
- The CIF File is at location `\progra~1\statneth\blaise\tools\cameleon\sas`.
- The Destination Folder for all the created models, meta information files, and Cameleon translations is `\test` (I believe in originality in choice of folder names).
- The Confirm Info: selection is used to stop the dialog being closed prematurely, if you hit an enter key by mistake. The dialog will only close if Accept or Reject is selected. The Maniplus setup runs the `Create_Models.CIF` translator to write a whole series of data model files, and to write a reference file (`SocEco4.REF`) in the working directory, containing the fully specified names of the data model files:

```
\test\soceco4_A01
\test\soceco4_A02
\test\soceco4_A04
\test\soceco4_A05
\test\soceco4_A06
\test\soceco4_A03
```

The first part of the name is the meta-information file name (`SocEco4`) and the second part (after the underscore) is the extension for the appropriate AsciiRelational file name. Listings of `SocEco4_A01.BLA` and `SocEco4_A06.BLA` are in the Appendix.
The SAS file written for `SocEco4_A06.BLA` is in the Appendix.

The elements of Models4

Apart from `Models_System.MAN`, the key elements of Models4 are the following:

- `Create_Models.CIF`
- `Generate_MetaInfo.MAN` (and, of course, `Generate_MetaInfo.MSF`)

Each file can be executed separately, and for `Create_Models.CIF` the command line is:

```
CAMELEON Create_Models /B /DSourceDataModelPath /PDestinationFolder
```

- The *`SourceDataModelPath`* is the fully specified path and name of the source data model — for example, `\progra~1\statneth\blaise\samples\soceco4`.

- There is one parameter: the *DestinationFolder* is the folder in which the models are created — for example, `\test`.

The command line for Manipula/Maniplus is (one line, though I have it split over two):

```
MANIPULA Generate_MetaInfo /ISourceDataModelName.REF /Q
    /PCifFilePath;DestinationFolder;DoPrepare;DoCIF /RSourceDataModelName.MSG
```

- The *SourceDataModelName* is the name of the source data model, to which is appended **.REF** — for example, `soceco4.REF` (this is the reference file). When `Generate_MetaInfo.MAN` is being run independently of the Models4 System, you can use any approriate file name.
- There are four parameters that follow the **/P**:

  CifFilePath (corresponds to CIF File in the dialog);
  DestinationFolder (corresponds to Destination Folder in the dialog);
  DoPrepare, that is, are the names in the reference file to be prepared? (Y if true);
  DoCIF, that is, are the names in the reference file to be translated by a CIF? (Y if true).
- The *SourceDataModelName* is the name of the source data model, to which is appended **.MSG** — for example, `soceco4.MSG` (this is the message file). When `Generate_MetaInfo.MAN` is being run independently of the Models4 System, you can use any approriate file name.

Appendix: Example listings

SocEco4.BLA (based on SocEco.BLA supplied with Blaise 4)

```
DATAMODEL SocEco4;     {Complete change from SocEco: TYPE and BLOCK}

PRIMARY PersonCode

TYPE
  TYesNo = (Yes,No)
  TFreqy = (Weekly, Monthly)
  TCode =   1..50
  TEarn =   0..10000

BLOCK PersonCodeBl
  FIELDS
    PersonCodeQ "What is your personal code?" : TCode
  RULES
    PersonCodeQ
ENDBLOCK

  BLOCK BSalary;
    FIELDS
      Income "Do you earn a regular salary?": TYesNo
      Amount "How much to you earn?": TEarn
      Period "Is this weekly or monthly?": TFreqy
    RULES
      Income
      IF Income = Yes THEN
        Amount
        Period
      ENDIF
  ENDBLOCK

  BLOCK BSeason
    FIELDS
      Income "Do you draw an income from seasonal work?": TYesNo
      Amount "How much do you earn per season?": TEarn
      RULES
        Income
        IF Income = Yes THEN
          Amount
          DUMMY
        ENDIF
  ENDBLOCK

  BLOCK BAllow
    FIELDS
      Income "Do you receive an allowance?": TYesNo
      Amount "How much do you receive?": TEarn
      Period "Is this weekly or monthly?": TFreqy
    RULES
      Income
      IF Income = Yes THEN
        Amount
        Period
      ENDIF
  ENDBLOCK
```

```
TABLE TIncome "Income specification"
  FIELDS
    Salary: BSalary
    Season: BSeason
    Allowance : BAllow
  RULES
    Salary
    Season
    Allowance
ENDTABLE

FIELDS
  PersonCode: PersonCodeBl
  Income: TIncome

RULES
  PersonCode
  Income
ENDMODEL
```

SocEco4_A01.BLA (An example data model)

```
DATAMODEL SocEco4 {FileNumber:= 1}

  FIELDS
    FPrimary: STRING[2]
    InstanceNumber: 0..99999
    PersonCode: 0..99999
    Income: 0..99999
ENDMODEL {SocEco}
```

SocEco4_A06.BLA (An example data model)

```
DATAMODEL BAllow {FileNumber:= 6}

  TYPE
    TYesNo = (Yes, No)
    TEarn = 0..10000
    TFreqy = (Weekly, Monthly)

  FIELDS
    FPrimary: STRING[2]
    InstanceNumber: 0..99999
    Income "Do you receive an allowance?": TYesNo
    Amount "How much do you receive?": TEarn
    Period "Is this weekly or monthly?": TFreqy
ENDMODEL {BAllow}
```

SocEco4_A06.SAS (An example SAS data description)

```
TITLE 'BAllow';

PROC FORMAT;

VALUE TE_1F
  1='Yes'
  2='No'
;

VALUE TE_2F
  1='Weekly'
  2='Monthly'
;
```

```
RUN;

DATA FILE;
INFILE 'soceco4_A06.ASC';
INPUT
    FPrimary $  1 -  2
    Instance    3 -  7
    Income      8 -  8
    Amount      9 - 13
    Period     14 - 14
;

LABEL
  FPrimary   = 'FPrimary'
  Instance   = 'InstanceNumber'
  Income     = 'Do you receive an allowance?'
  Amount     = 'How much do you receive?'
  Period     = 'Is this weekly or monthly?'
;

FORMAT
  Income    TE_1F.
  Period    TE_2F.
;

RUN;
```

Imputation with Blaise and Manipula

Jelke Bethlehem and Lon Hofman, Statistics Netherlands

1. Introduction

Statistical surveys are always affected by non-response. There is item non-response, in which only the answers to some questions are missing, and there is also unit non-response, in which the answers to all questions are missing. For many years now Statistics Netherlands has been confronted with severe non-response problems. This is mainly unit non-response. Consequently, research has concentrated on correction techniques for this type of non-response. One of the products of this research is the program Bascula for adjustment weighting.

The last couple of years there has been increased attention for item non-response. This is usually taken care of by means of imputation techniques. Imputation comes down to making an estimate for the missing answer according to some model, and substituting these synthetic values in the data file. The paper presents a methodological overview of various imputation methods, and shows how they can be implemented using Blaise and Manipula.

2. The non-response problem

Survey sampling is a well-established sampling method. By choosing a proper sampling design, it is possible to compute accurate estimates based on relatively small samples. This allows for cost-effective data collection and timely publications. However, there also is another side to this coin. Not everything is under control. There are practical problems hindering a smooth execution of sample surveys. One of the most important problems survey organisations have been facing over the last decades is non-response.

Non-response is the phenomenon that elements (persons, households, companies) in the selected sample do not provide the requested information, or that the provided information is useless. The situation in which all requested information on an element is missing is called *unit non-response*. If information is missing on some items only, it is called *item non-response*. This chapter will only handle unit non-response.

Due to non-response the sample size is smaller than expected. This leads to less accurate, but still valid, estimates of population characteristics. This is not a serious problem. It can be taken care of by taking the initial sample size larger. A far more serious problem caused by non-response is that estimates of population characteristics may be biased. This situation occurs if, due to non-response, some groups in the population are over- or underrepresented, and these groups behave differently with respect to the characteristics to be investigated.

Indeed, estimators must be assumed to be biased unless very convincing evidence of the contrary is provided. Bethlehem and Kersten (1987) discuss a number of surveys of Statistics Netherlands. A follow-

up study of the Victimisation Survey showed that people who have fear when they are alone at night, are less inclined to participate in the survey. In Housing Demand Surveys it turned out that people who refuse to co-operate, have a lesser housing demand than responding people. For the Survey on the Mobility of the Population it is obvious that mobile people are relatively under-represented among the respondents.

Figure 1.1. Non-response percentages of some Statistics Netherlands surveys

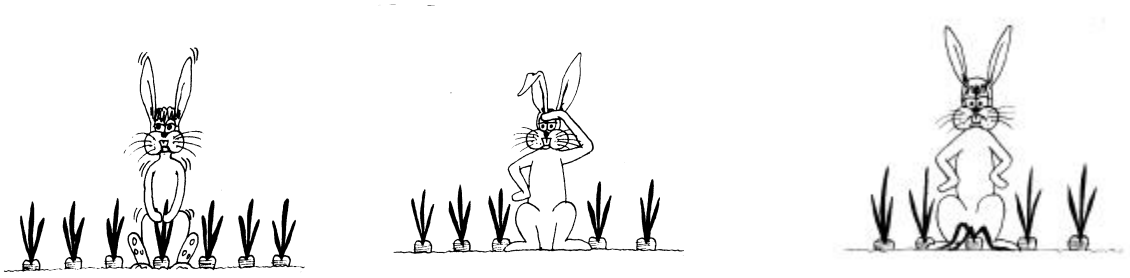
Year	Labour Force Survey	Consumer Sentiments Survey	Survey on Well-being	Mobility Survey	Holiday Survey
1972		29			
1973	12	23			
1974		25	28		
1975	14	22			14
1976		28	23 [2])		13
1977	12	31	30		19
1978		36		33	22
1979	19	37	35 [3])	31	26
1980		39	39	32	26
1981	17	35		32	26
1982		40	36 [2])	34	29
1983	19	37	42	34	26
1984		35 [1])		36	31
1985	23	31		39	32
1986		29	41	41	34
1987	40 [1])	29		41	
1988	41	32		45	
1989	39	32		42	
1990	39	32		45	
1991	40	31		43	
1992	42	31	55	43	
1993	42		54	44	
1994	41		48 [1])	45	
1995	40		46	46	
1996	42		48	48	
1997	44			50	

[1]) Revision [2]) Young people only [3]) Old people only

The magnitude of the non-response in many Dutch sample surveys is increasing to such an extent that without special adjustment techniques one has to reckon with a decrease of the quality of the results. Figure 1.1 presents non-response figures of a number of surveys carried out Statistics Netherlands.

It is difficult to compare response rates from different surveys but for each of the surveys one can study its non-response figures over the years. The magnitude of the non-response is determined by a large number of factors, including the subject of the survey, the target population, the time period, the length of the questionnaire, the quality of the interviewers, the fieldwork in general, etc. It is also clear from figure 1.1 that non-response is a considerable problem. It has an impact on the costs of a survey, since it takes more and more effort to obtain estimates with the same precision as originally specified in the sampling design.

Figure 1.2. Reasons for non-response



Non-respondents can be classified in three important groups, see figure 1.2. People in the first group refuse to co-operate. Sometimes it is possible to make an appointment for an interview at some later date. However, frequently the refusal can be considered permanent. Possible causes are fear of privacy intrusion, and interview fatigue. The second group of non-respondents is the not-contactable. No contact is made due to the fact people are not at home, due to removal or due to other circumstances like watchdogs, dangerous neighbourhoods or houses which are difficult to reach. Generally speaking, people are increasingly hard to contact. Important factors are smaller family sizes, greater mobility and a larger amount of spare time that is spent out-of-doors. The third group of non-respondents consists of people who are physically or mentally not able to co-operate during the fieldwork period. Also language problems can cause this type of non-response.

To be able to build a well-founded theory of non-response adjustment it is necessary to incorporate the phenomenon of non-response in the theory of sampling. The literature on non-response contains two different basic views on how non-response occurs. Here, these views are labelled the Random Response Model and the Fixed Response Model.

The *Random Response Model* assumes some kind of random mechanism determining whether or not a selected person will respond. Each element in the population is assigned an imaginary random number generator. This generator can only produce either the value 0 or 1. A value 1 means response, and a value 0 non-response. The probability with which the random number generator assumes the value 1, is different for each element in the population. All response probabilities are assumed to be unknown. Under the Random Response Model, there are two random processes controlling the availability of data: the sample selection mechanism defined by the researcher, and the response mechanism that is not under his control.

The *Fixed Response Model* assumes the population to consist of two mutually exclusive and exhaustive sub-populations: the response stratum and the non-response stratum. Elements in the response stratum would participate in the survey with certainty, if selected in the sample, and elements in the non-response stratum would not participate with certainty, if selected. The Fixed Response Model can be regarded as a special case of the Random Response Model in which the response probabilities are either 0 or 1. Many authors consider the Fixed Response Model a too simple and unrealistic model.

Both models can be used to study the effect of non-response on estimates of population estimates, and the conclusions from both models are the same: generally, these estimates will be biased, and the size of the bias is determined by two factors:

- The non-response rate. The higher the non-response rate, the larger the bias. For very small non-response rates, the bias may be ignored, but high non-response rates may incur a substantial bias.

- The extent to which non-respondents differ from respondents. The larger the difference between the average values of respondents and non-respondents, the larger the bias will be. If the non-respondents can be considered to be a random sub-sample, there will be no bias.

In practice, it is very difficult to asses the possible negative effects of non-response. And even if such effects can be detected, it is no simple matter to correct for them. A correction is only possible if auxiliary information is available. For example, if there is an auxiliary variable that has been measured in the sample, and for which population characteristics are know, then this variable can be used to check whether the available data show unbalancedness, i.e. they are not representative for the population.

An example illustrates this. Suppose, a sample of municipalities is selected in order to estimate the average milk production. Due to non-response not all municipalities provide information. Suppose that also the number of farms per municipality is measured as an auxiliary variable. If the average number of farms per municipality in the sample is 69, and it is known that the population average is 91, then there is something wrong. Apparently, municipalities with a small number of farms are over-represented in the survey. Taking into account that these small municipalities will also have a small milk production, it is likely that the average milk production will be under-estimated.

3. Correction for non-response

There are two approaches to non-response correction. The first approach relates to unit non-response, the situation in which all requested information on an element is missing. To correct for a possible bias due to unit non-response, often a weighting method is carried out.

The basic principle of *weighting* is that every observed element is assigned a specific weight. By processing the weighted values instead of the values themselves estimates for population characteristics are obtained. The easiest and most straightforward method used to compute weights is post-stratification. The population is divided into strata after selection of the sample. If each stratum is homogeneous with respect to the target variable of the survey, then the observed elements resemble the unobserved elements. Therefore, estimates of stratum characteristics will not be very biased, so they can be used to construct population estimates.

To carry out post-stratification, discrete auxiliary variables are needed, and preferable auxiliary variables having a strong relationship with the target variable. All observed elements within a stratum are assigned the same weight, and this weight is computed such that the weighted sample distribution of the auxiliary variables agrees with the population distribution of these variables. If the relationships are strong enough, also the weighted sample distribution of the target variable will agree with its population distribution.

There are also more advanced weighting methods, see e.g. Bethlehem and Keller (1987), and Deville and Särndal (1992). Several types of weighting have been implemented in the package Bascula. For more information about Bascula, see Bethlehem (1997).

The second approach to non-response correction relates to item non-response, the situation in which only part of the requested information about an element is missing. In this case only some questions in the questionnaire have remained unanswered, but these are usually the sensitive questions. Item non-response requires a different approach. A great deal of additional information is available for the elements involved. All available responses to other questions can be used to predict the answer to the missing questions. This computation of a 'synthetic' answer to a question is called *imputation.* The Blaise family of software packages does not (yet) contain a package of imputation. However, many imputation techniques can be implemented using Manipula. Section 4 discusses some of the theoretical background of imputation. And section 5 shows some ways of implementing imputation techniques in Blaise and Manipula.

4. Some theory of imputation

Imputation relates to a family of techniques for replacing missing values in a data set by 'synthetic values' obtained from some kind of model. Such a model describes a relationship between the variable having missing values and other variables for which the values are available.

Let Y denote the *target variable* having missing values that must be imputed. Furthermore, there are a number of *auxiliary variables* X_1, X_2, … used to predict the missing values of the target variable.The prediction model is estimated using only those records in the data file for which values of both the target variable and the set of auxiliary variables is available. Next, the model is used to predict the missing values of Y. For each missing value, the set of values of the auxiliary variables is substituted in the model, which results in a predicted value of Y.

Imputation techniques can range from simple ad hoc procedures to sophisticated prediction techniques based on complex models. Kalton and Kasprzyk present a list of some commonly used imputation techniques:

- *Deductive imputation.* Sometimes, the missing answer to a question can be deduced with certainty from the available answers to other questions. When range, consistency and route checks restrict the answer to only one possible value, deductive imputation can be applied. This is the ideal form of imputation.

- *Imputation of the mean.* This technique substitutes the mean of the available values of the target variable Y for all missing values of Y.

- *Imputation of the group mean.* The sample is divided into groups using auxiliary variables. Within each group, the mean of the available values of Y is assigned to all missing values of Y.

- *Random imputation.* For each missing value of Y, a value is chosen at random from the set of available values of this variable.

- *Random imputation within groups.* The sample is divided into groups using auxiliary variables. Within each group, a missing value is substituted by a randomly chosen value from the set of available values of Y within the group.

- *Hot-deck imputation.* This is a special implementation of random imputation within groups. For each group, a donor record is maintained. The records in the file are processed sequentially. If the field of the variable to be imputed contains a 'real' value, the value is copied to the donor record. If the value in the field is missing, the value from the donor record is copied to the field.

- *Regression imputation.* A regression model is constructed that explains the values of the target variable Y from the values of auxiliary variables X_1, X_2, … Then, the fitted regression model is used to predict the answer in missing cases. To conserve the distributional properties of the data, often a residual, drawn from some normal distribution, is added to the prediction.

At the first sight, these techniques appear to be rather diverse. Still, most of them can be put into a general framework. Let Y_i denote the value of the target variable Y in the i-th record (for i = 1,2, …, n). Suppose there are p auxiliary variables X_1, X_2, …, X_p. The values of these variables in the i-th record are denoted by X_{i1}, X_{i2}, …, X_{ip}. If the value Y_i is missing, a general expression of the imputed value can be obtained from

$$\hat{Y}_i = b_0 + \sum_{j=1}^{p} b_j X_{ij} + E_i, \qquad (4.1)$$

where $\hat{Y}_i$ denotes the imputed value, X_{ij} the value of the j-th auxiliary variable, b_0, b_1, …, b_p are regression coefficients, and E_i is the value of a random variable E obtained by drawing a value from some specific distribution depending on the chosen imputation technique.

It is clear that expression (4.1) includes regression imputation. If all values of E are set to 0, the imputed value is the value predicted by the regression model. Often a residual noise variable is added to the prediction by the regression model. This is done to conserve the distributional properties of the target variable Y. The value of the noise variable is obtained by drawing some value from a normal distribution.

If the auxiliary variables are taken to be dummy variables representing imputation groups, expression (4.1) can be used for imputation of the group mean. For this, b_0 and the E_i's must be set to 0. The remaining b_j's must be taken equal to group means of Y, i.e.

$$b_j = \overline{Y}_j,$$

for j = 1, 2, …, p. Within this framework, imputation of the mean is the special case of imputation of the group mean. It is obtained by introducing only one group, i.e. there is one auxiliary variable X_1, and it always has the value 1.

Random imputation within groups is obtained by adding a noise variable to the model for imputation of the mean. The auxiliary variables are dummy variables representing the groups, $b_0 = 0$, and b_1, b_2, …, b_p are the group means of Y. For each group j, a set of values

$$E_{ij} = \overline{Y}_j - Y_{ij}$$

(for i=1,2,…) is formed. The Y_{ij} denote the values of Y in the j-th group. The noise value E_i is obtained by selecting a random value from the proper set of values, i.e. if record i belongs to group j, E_i is selected from E_{1j}, E_{2j}, … . Random imputation is a special case. It is obtained by using only one group.

Hot-deck imputation is a special implementation of random imputation within groups. If the order of the records in the data file is completely random, both techniques are more or less equivalent.

The success of an imputation technique depends on properties of the mechanism generating item non-response. Little and Rubin (1987) consider three types of patterns leading to missing data:

1? The probability of a missing value of Y is independent of the value of Y and independent of the value of the X's. This case is called *Missing Completely At Random* (MCAR). Then the observed values of Y form a random sub-sample from the sample. The mean of the observed values is an unbiased estimate of the population mean.

2? The probability of a missing value of Y depends on the value of X but is independent of the value of Y's. This case is called *Missing At Random* (MAR). Then the observed values of Y do not form a random sub-sample of the sample. However, they are a random sub-sample within the classes defined by the values of the X's. The auxiliary variables can be used to effectively correct for a bias due to missing values.

3? The probability of a missing value of Y depends both on the value of Y and the values of X's. Then the observed values of Y do not form a random sub-sample of the sample. Also, they are not a random sub-sample within the classes defined by the values of X. Therefore, the auxiliary variable cannot be used to effectively correct for a bias due to missing values.

There are several considerations that play a role in selecting an imputation technique. One is the type of the target variable. All techniques listed above can be applied routinely on qualitative (continuous) variables. However, some of the techniques cannot be applied to quantitative (discrete or categorical) variables, because imputed values will not necessarily belong to the domain of valid values. For example, imputation of the mean or regression imputation for a variable Sex with two possible values (1 for male, and 2 for female) may easily produce a value like 1.4. So, for a qualitative variable it is better to only use random imputation (possibly within groups) or hot-deck imputation. These techniques always produce 'real' values.

Imputation techniques can be classified as random or deterministic, depending on whether a noise variable is used or not. The deterministic techniques usually work in such a way that the mean of all values (observed and imputed) is equal to the mean of the observed values. For the random imputation methods, the expected value (over the residual producing mechanism) of the mean over all values is equal to the observed mean. So both methods have the same effect on the bias of estimates. However, adding noise introduces an extra source of variation, and therefore reduces the precision of estimates. This may be a reason to prefer deterministic techniques for estimating the population mean.

Deterministic techniques have the disadvantage that they distort the properties of the distribution of the values of the variable. These techniques tend to predict values in the middle part of the distribution. The distribution of Y in the imputed data set is much more peaked and much more concentrated than the original distribution. Therefore, standard errors computed from the imputed data set are generally too small. They create a too optimistic view of the precision of estimates. Random imputation methods do not have this nasty property. They are much better able to preserve the original distribution.

A final point to take into consideration is the effect of imputation on relationships between variables. Imputation of the overall mean and random imputation causes covariances and correlations to be biased. This occurs because imputed Y values are uncorrelated with the values of other variables in the records. By applying imputation within groups, the bias is decreased, but not avoided. Also, regression imputation (with or without a residual) introduces a bias in the covariance.

It is clear that the ideal imputation technique does not exist. A researcher always has to be careful in the analysis of a data set that has been subject to imputation (unless the amount of imputation is small). Research for new imputation techniques is still in progress. An example is the multiple imputation technique proposed by Rubin(1979). This technique computes a set of, say *m* imputed values for each missing value. This results in *m* imputed data sets. Inference is based on the distribution obtained by computing the estimate for each of the *m* data sets.

Also, application of neural networks and of evolutionary algorithms looks promising. Experiments have shown that there are situations in which these techniques are useful. However, further research is necessary.

5. Imputation in Blaise

Simple deductive imputation can be carried out with the Data Entry Program (DEP) of Blaise itself. By means of compute instructions in the rules section answers to questions can be computed. Most other imputation techniques require information from other records, or from all records. Since the DEP is a form oriented utility, it is less convenient to use, or even impossible for these techniques. Manipula is much more suitable in these cases.

This section shows how a number of imputation techniques can be implemented in Manipula. A simple example is used to illustrate these techniques. A data file has been constructed for females with a job in the country of Samplonia. The file contains three variables: Province (with two values Agria and Induston), Age (in the range from 20 to 65), and Income (in the range from 0 to 1500). In five records the value of Income is missing. We will show what happens if various imputation techniques are used to replace the missing values of income by imputed values.

In Samplonia, there is a clear relationship between income, age and province. Figure 5.1 shows a scatterplot of this relationship. Two distinct clusters can be distinguished. The upper cluster relates to the province of Induston, and the lower cluster contains data from Agria. Apparently, incomes are higher in Induston, and increase with age. Incomes in Agria are low and independent from age. Of the five missing observations, two are from Induston, and three from Agria. A good imputation technique will take the structure into account, and produce imputed values that fit nicely in these clusters.

Figure 5.1. The relationship between income, age and province for females in Samplonia

Figure 5.2. contains the Manipula setup for the simplest imputation technique. It is imputation of the overall mean of the available values of income.

Figure 5.2. Manipula setup for imputation of the mean

```
SETTINGS
  AUTOREAD = NO

USES
  BlaiseData 'Samfem'

UPDATEFILE
  UpFile: BlaiseData ('Samfem', BLAISE)
SETTINGS
  CHECKRULES = YES

AUXFIELDS
  RMean: REAL
```

```
  IMean: INTEGER
  RecNum: INTEGER
  N: INTEGER

MANIPULATE
  FOR RecNum:= 1 TO UpFile.RECORDCOUNT DO
    UpFile.READNEXT
    IF Income <> EMPTY THEN
      RMean:= RMean + Income
      N:= N + 1
    ENDIF
  ENDDO

  IMean:= RMean / N
  UpFile.RESET

  FOR RecNum:= 1 TO UpFile.RECORDCOUNT DO
    UpFile.READNEXT
    IF Income = EMPTY THEN
      Income:= IMean
      Imputed:= 1
      UpFile.Write
    ENDIF
  ENDDO
```

In the Settings section *AUTOREAD* is set to *NO*. This makes it possible to make several runs through the data file in the same setup. In this example, there are two runs. In the first run, the mean is computed, and assigned to the temporary variable *IMean*. Note that the check *IF Income <> EMPTY* sees to it that the mean is computed over all 'real' values. The variable *N* counts the number of these observations. In the second run the value of the mean is assigned to the variable *Income* in all cases for which the value of Income is missing.

The Blaise model contains a field with the name Imputed. This field records whether the value of Income is 'real' or imputed. Such an imputation flag may be important for future analyse of the data.

In this example, the value of the overall mean is equal to 429. This value lies somewhere between the two clusters in the scatterplot. Therefore it is bad imputation technique in this case. The overall mean of income is not affected, but the structure of the relationship between income and age is distorted.

Figure 5.3. contains the Manipula setup for imputation of the group means, where in this case the groups are the two provinces.

Figure 5.3. Manipula setup for imputation of the mean within groups

```
SETTINGS
  AUTOREAD = NO

USES
  BlaiseData 'Samfem'

UPDATEFILE
  UpFile: BlaiseData ('Samfem', BLAISE)
SETTINGS
  CHECKRULES = YES

AUXFIELDS
  RMean: ARRAY[1..2] OF REAL
  IMean: ARRAY[1..2] OF INTEGER
  N: ARRAY[1..2] OF INTEGER
  RecNum: INTEGER
  I: INTEGER

MANIPULATE
  FOR RecNum:= 1 TO UpFile.RECORDCOUNT DO
    UpFile.READNEXT
    IF Income <> EMPTY THEN
      RMean[Province]:= RMean[Province] + Income
      N[Province]:= N[Province] + 1
    ENDIF
  ENDDO

  FOR I:= 1 TO 2 DO
    IMean[I]:= RMean[I] / N[I]
  ENDDO
  UpFile.RESET

  FOR RecNum:= 1 TO UpFile.RECORDCOUNT DO
    UpFile.READNEXT
    IF Income = EMPTY THEN
      Income:= IMean[Province]
      Imputed:= 1
```

```
      UpFile.Write
    ENDIF
  ENDDO
```

The difference with the previous setup in figure 5.2 is that now group means are computed for each province separately. So there is now an array of group means. The number of ‘real’observations in each group is also counted in an array.

The imputed group mean for the province of Induston is equal to 995. For missing values in Induston this is a better value than for imputation of the overall mean. Nevertheless, it is not ideal. The elderly people with high incomes (up to a value of 1405) would also get an imputed value of 995. The imputed value is too low. And for young people the imputed value would be too high. For the province of Agria, the imputed value is 153. This looks reasonable, since income seems to be more or less constant in this province.

Figure 5.4 contains the Manipula set for random imputation. Also for this technique, two runs must be made through the data file: one to collect all ‘real’values of income, and one to randomly assign values from this set to records having missing values.

Figure 5.4. Manipula setup for random imputation

```
SETTINGS
  AUTOREAD = NO

USES
  BlaiseData 'Samfem'
  DATAMODEL MValues
    PRIMARY
      RecNr
    FIELDS
      RecNr: INTEGER[4]
      Income: 0..6000
  ENDMODEL

UPDATEFILE
  UpFile: BlaiseData ('Samfem', BLAISE)
SETTINGS
  CHECKRULES = YES
```

```
TEMPORARYFILE
  Values: MValues
SETTINGS
  AUTOCOPY = NO

AUXFIELDS
  RecNum: INTEGER
  N: INTEGER

MANIPULATE
  FOR RecNum:= 1 TO UpFile.RECORDCOUNT DO
    UpFile.READNEXT
    IF Income <> EMPTY THEN
      N:= N + 1
      RecNr:= N
      Values.WRITE
    ENDIF
  ENDDO

  UpFile.RESET

  FOR RecNum:= 1 TO UpFile.RECORDCOUNT DO
    UpFile.READNEXT
    IF Income = EMPTY THEN
      Values.GET(RANDOM(N) + 1)       { read random record    }
      UpFile.Income:= Values.Income   { the actual imputation }
      UpFile.Imputed:= 1
      UpFile.Write
    ENDIF
  ENDDO
```

Note that the ‘real’values of income are stored in a temporary file *Values*. As primary key for this file the record number is used. The total number of ‘real’ values is counted in the variable *N*. The function call *RANDOM(N)* generates a random integer from the set 0 up to and including N-1. So, to get a value in the range from 1 to N, we have added 1 to the result of the function call. The *GET* instruction is used to retrieve a record with a ‘real’ income value from the temporary file *Values*.

Application of this imputation technique will result in assignment of random income values to records with missing values. It is possible that the missing income in the province of Agria will be replaced by an income value from the province of Induston. It will be clear that random imputation will distort the structure of the relationship between income and age within the provinces.

Figure 5.5 contains the Manipula setup for random imputation within groups. It is an extension of the setup in figure 5.4. The temporary file has been extended with the variable *Province*. This variable has also been included in the primary key of the temporary file. All 'real' income values are again written to the temporary file with the appropriate value for the primary key. For each group, missing income values are replaced by a randomly selected 'real' income from the temporary file.

Figure 5.5. Manipula setup for random imputation within groups

```
SETTINGS
  AUTOREAD = NO

USES
  BlaiseData 'Samfem'
  DATAMODEL MValues
    PRIMARY
      Province, RecNr
    FIELDS
      Province: (Agria, Induston)
      RecNr: INTEGER[4]
      Income: 0..6000, EMPTY
  ENDMODEL



UPDATEFILE
  UpFile: BlaiseData ('Samfem', BLAISE)
SETTINGS
  CHECKRULES = YES

TEMPORARYFILE
  Values: MValues
SETTINGS
  AUTOCOPY=NO

AUXFIELDS
  N: ARRAY[1..2] OF INTEGER
  RecNum: INTEGER

MANIPULATE
```

```
FOR RecNum:= 1 TO UpFile.RECORDCOUNT DO
  UpFile.READNEXT
  IF Income <> EMPTY THEN
    N[Province]:= N[Province] + 1
    RecNr:= N[Province]
    Values.WRITE
  ENDIF
ENDDO

UpFile.RESET

FOR RecNum:= 1 TO UpFile.RECORDCOUNT DO
  UpFile.READNEXT
  IF Income = EMPTY THEN
    Values.GET(Province, RANDOM(N[Province]) + 1) { read random record }
    UpFile.Income:= Values.Income                { the actual imputation }
    UpFile Imputed:= 1
    UpFile.Write
  ENDIF
ENDDO
```

Random imputation within groups is better than random imputation. Still, it suffers from the same drawbacks as imputation of the group means: elderly people (with a high income) in Induston could be assigned the value of the income of a younger person, and thus would get a too low income.

Figure 5.6 contains the Manipula setup for a hot-deck imputation technique. The big advantage of hot-deck imputation is that it requires only one run through the data file. In this example there are two groups, corresponding to the two provinces. For each group, the last encountered value of income in that group is stored in the array *Donor*. When a missing value is encountered, it is replaced by the value in the donor array.

Note that in the present form, the setup has a shortcoming. The setup assumes the donor array will be filled with 'real' values at the moment the first missing value is encountered. If the first record in the data file contains a missing value, a value of 0 will be imputed. In a real production situation, the setup must be adapted to take care of this situation. Under the assumption that the order of the records in the data file is more or less arbitrary, hot-deck imputation has more or less the same properties as random imputation within groups.

Figure 5.6. Manipula setup for hot-deck imputation

```
SETTINGS
```

```
  AUTOREAD = NO

USES
  BlaiseData 'Samfem'

UPDATEFILE
  UpFile: BlaiseData ('Samfem', BLAISE)
SETTINGS
  CHECKRULES = YES

AUXFIELDS
  Donor: ARRAY[1..2] OF INTEGER
  RecNum: INTEGER

MANIPULATE
  FOR RecNum:= 1 TO UpFile.RECORDCOUNT DO
    UpFile.READNEXT
    IF Income <> EMPTY THEN
      Donor[Province]:= Income
    ELSE
      Income:= Donor[Province]
      Imputed:= 1
      UpFile.WRITE
    ENDIF
  ENDDO
```

Figure 5.7 contains the final Manipula setup to be considered. It contains an example of regression imputation. At first sight, this also seems to be a case of one run through the data file. But this is not true. In order to compute the coefficients of the regression model, also a run through the file must be made. Manipula is not the most convenient package for regression analysis. There are many statistical analysis packages that are better equipped for this purpose. Fortunately, Blaise offers tools to use these packages in a convenient way. For the current example, Cameleon was used to export to data to SPSS. A regression analysis was carried out in SPSS, and this resulted in the following model:

$$\text{Income} = 160 \times (2 - \text{Province}) + (209 + 20 \times \text{Age}) \times (\text{Province} - 1).$$

For a missing value in the province of Agria, the value of the variable Province is equal to 1, and so the model reduces to

$$\text{Income} = 160.$$

Apparently, always a value of 160 is predicted for Income, and this is not so bad if we look at the scatterplot in figure 5.1. For a missing value in the province of Induston, the value of the variable Province is equal to 2, and so the model reduces to

$$\text{Income} = 209 + 20 \times \text{Age}.$$

The imputed value of income increases with age. The straight line corresponding to this model follows the upper cluster of points in the scatterplot. Clearly, this regression imputation is the best imputation of the techniques discusses in this section.

Figure 5.6. Manipula setup for regression imputation

```
SETTINGS
  AUTOREAD = NO

USES
  BlaiseData 'Samfem'

UPDATEFILE
  UpFile: BlaiseData ('Samfem', BLAISE)
SETTINGS
  CHECKRULES = YES

AUXFIELDS
  RecNum: INTEGER

MANIPULATE
  FOR RecNum:= 1 TO UpFile.RECORDCOUNT DO
    UpFile.READNEXT
    IF Income = EMPTY THEN
      Income:= (2 - Province) * 160 + (Province - 1) * (209 + 20 * Age)
      Imputed:= 1
      UpFile.WRITE
    ENDIF
  ENDDO
```

6. Conclusion

Imputation is a much-used technique to get rid of missing values in a data file. That is what is does and not much more. Particularly if the pattern of missing values is not random, imputation may distort the properties of distribution of the variables. So care must be taken to select a proper imputation technique.

Although the Blaise System has no dedicated tools for imputation, it is not very difficult to implement it. Manipula seems to have all that is needed for carrying out imputation.

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Diary and Office Processing : Integrating Blaise with other facilities

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1. Introduction

The Australian Bureau of Statistics (ABS) first made use of Blaise (version III) in a production application in 1996, when it was used for the collection of data in the longitudinal Survey of Employment and Unemployment Patterns. This followed almost two years of testing and development of systems associated with computer assisted interviewing (CAI). Since then, Blaise software has been used successfully for computer assisted interviewing in a number of other surveys, as well as for office based data capture of diary records from the Time Use Survey.

While Blaise has been used primarily for data capture, it has also been used successfully in the development of office management systems for CAI (Henden et al, 1997). The success of Blaise in these applications, together with its flexibility and versatility, made it a strong contender for capturing diary records from the 1998/99 Household Expenditure Survey.

This paper describes the systems that have been developed for diary data capture and how they have been integrated into the ABS computing environment. The paper also discusses some of the issues that had to be dealt with.

2. Household Expenditure Survey

The Household Expenditure Survey (HES) is a national survey conducted by the ABS approximately every five years. The current HES has a target sample of around 8,000 households and is being conducted over a 12-month period, which commenced in July 1998.

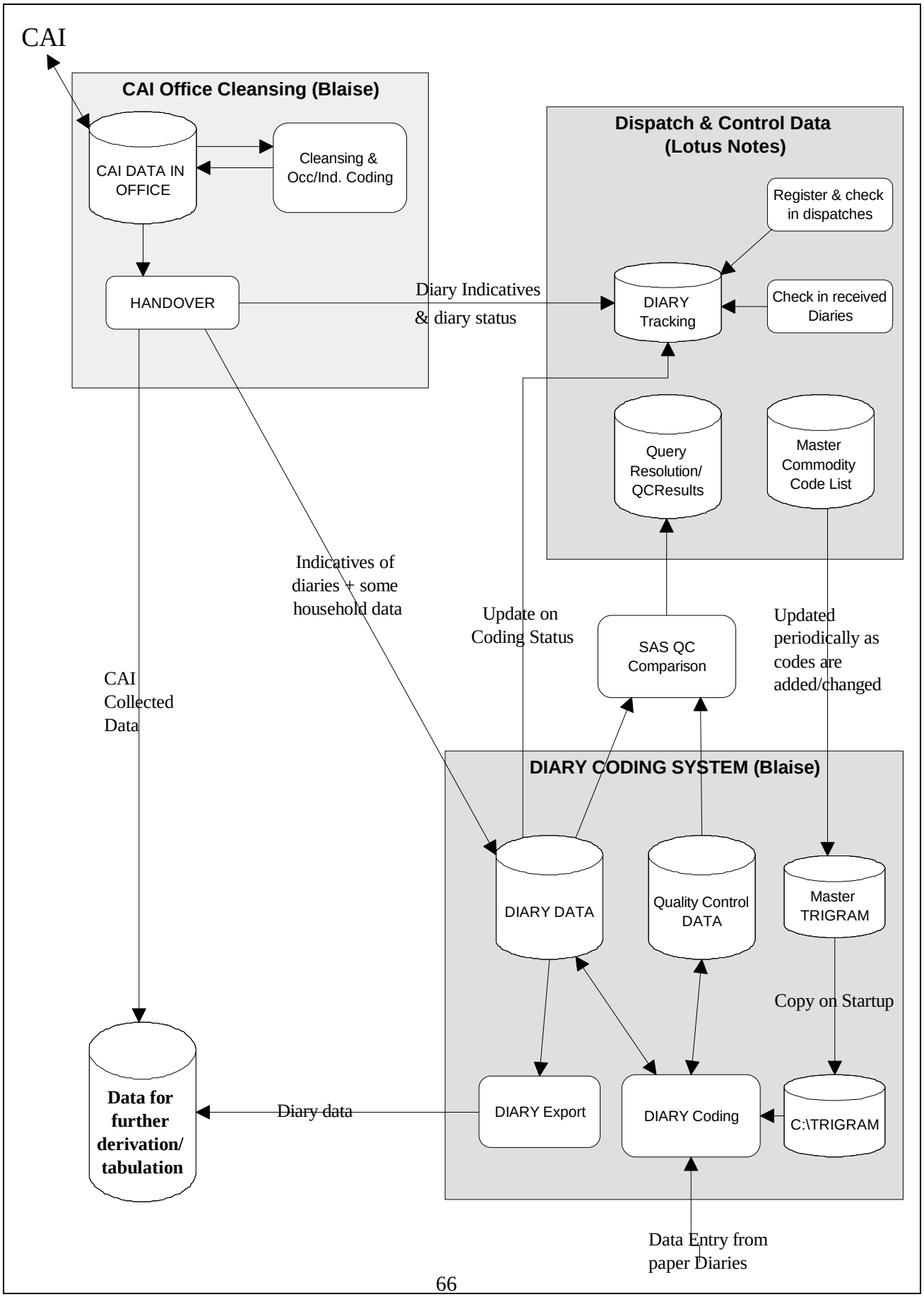
The data collection and input processing methodology for the current HES is significantly different to the methodologies used for the last three surveys. This time, the field interviewers are using CAI technology (Blaise III) to collect the initial household and individual data. After electronic transmission to the office, this part of the data is then coded and "cleaned" through the Office Management System (in Blaise) before it is exported to other systems for output processing.

Detailed personal expenditure data is collected using diaries, which are left for respondents to complete over the two weeks following their initial interview. While the collection of dairy data uses the same methodology as for previous surveys, the data entry of these diaries is being done through a Blaise Diary Processing System, which links with the CAI Office Management System previously mentioned. The diary data capture and coding processes are carried out at a single HES Processing Centre to ensure consistency in coding. Over the 12 months of the survey the Centre is expected to process around 32,000 diaries (two per adult in each responding household).

In addition to the Office Management System and Diary Processing System, it was also necessary to establish some additional process management facilities to keep track of the diaries, assist with quality control and resolve coding queries. While both systems are Blaise-based, the process management facilities have been built in Windows-based Lotus Notes for reasons which are discussed in the next section.

The following diagram shows the various components of the HES diary system.

Figure 1. HES Diary System diagram


CAI
CAI Office Cleansing (Blaise)
CAI DATA IN OFFICE
Cleansing & Occ/Ind. Coding
HANDOVER
Dispatch & Control Data (Lotus Notes)
Register & check in dispatches
DIARY Tracking
Check in received Diaries
Query Resolution/ QCResults
Master Commodity Code List
Diary Indicatives & diary status
Indicatives of diaries + some household data
Update on Coding Status
SAS QC Comparison
Updated periodically as codes are added/changed
CAI Collected Data
DIARY CODING SYSTEM (Blaise)
DIARY DATA
Quality Control DATA
Master TRIGRAM
Copy on Startup
Data for further derivation/ tabulation
Diary data
DIARY Export
DIARY Coding
C:\TRIGRAM
Data Entry from paper Diaries

3. Computer infrastructure issues

The ABS computer environment consists of approximately 3,200 personal computers, connected to a variety of platforms including the mainframe, native UNIX servers, and Notes (Lotus) and Banyan servers. This network provides universal access to all computer services from any desktop PC.

The main desktop software is Lotus Notes which not only provides Email and document management, but also provides functionality for development of smaller applications, including support for workflow applications.

In the past 7 years there has been a tendency to migrate the larger statistical processing systems from the mainframe computer to client-server on the midrange platform. In recent years the ABS has also developed a central corporate information warehouse which is used to store and disseminate all publishable data, and provides a single "one-stop shop" for all statistical output.

Many smaller applications are now being built in the Windows/Notes environment, or at least with a Windows/Notes front-end. Regardless of the platform or software being used, it is ABS policy that all statistical and processing applications must have metadata links to the corporate information warehouse and deliver their final data to it.

While there has been use of Blaise (version III) in the ABS since 1994, that was mainly for computer assisted interviewing in the field. Only limited use of Blaise has been made in the office and that has largely been associated with the management and cleaning of CAI data. Once the data has been cleared through these office management facilities it is generally exported and processed further in SAS or using other corporate software.

All desktop computers were converted to use Windows 95 by early 1997 and since that time very few applications make use of DOS. This has made the position of DOS-based Blaise software rather tenuous although the Windows 95 release of Blaise 4 should counteract this.

Most office-based staff of the ABS are now accustomed to using Windows based technology for their applications. This is a significant consideration when deciding which software should be used to build various parts of the diary processing system. There was a clear preference for Windows/Notes to be used for those parts which are used for monitoring and control because that is the familiar environment for staff involved in that activity. Use of Notes for monitoring and process control would also make that information more readily accessible to other staff throughout the ABS. The abundance of skilled Notes programmers as compared to those skilled in Manipula and Maniplus was also a relevant factor. The following components of the diary processing system were therefore built in Lotus Notes:

- Diary tracking facility - to keep track of all diaries, their location and status;
- Facility to manage the commodity code list and entries used for trigram coding;
- Query resolution facility - to record and resolve coding problems that arise;
- Facility for quality control - records the results of quality control checking.

These are described in more detail later.

4. Choice of Blaise for diary capture

While the decision to use Notes for the diary management facilities was relatively straightforward, the question of which software to use for the data entry and coding processes was not so easy. The presence of a Windows interface was a factor to be considered but it rated as only a minor issue compared to functionality and performance.

As mentioned in the introduction, the successful use of Blaise for data capture in other surveys, together with its flexibility and versatility, made it a strong contender for capturing diary records. The other contender for diary data capture was an ABS developed facility known as IPS (Input Processing System) which is used extensively for business surveys (involving mail out questionnaires) and some household surveys. IPS was developed in Oracle/SQL-Windows/C and provides a standardised environment for data entry of form based data.

Both data entry facilities were considered to be capable of being used for capturing HES diaries and there was sufficient experience and existing infrastructure for a system to be built using either. It was therefore decided to conduct a small-scale test of both options, using working prototypes of the data capture

instrument, to examine the relative performance of each. The test was carried out by two coding staff who coded the same diaries using both systems. Each system was tested for two days in succession and performance measures were taken as follows:

- total number of diaries entered;
- elapsed time to enter each diary;
- number of entries per diary;
- quality of coded data (missing entries, errors in coding, etc);
- load on ABS infrastructure (UNIX load, Banyan server load, network load and storage).

In addition to these measures, the coding staff were asked to comment on the performance and useability of each system. When the testing was completed, estimates were then made of the projected cost of using both systems for all diaries.

The detailed results of testing are summarised in tables at Figure 2.

Figure 2. Comparison of test results between Blaise and IPS (a)

Diaries entered		**Blaise**	**IPS**
Total number of diaries entered		88	52
Time to enter diary (Minutes)	Mean	15.3	26.1
	Median	8.4	19.5
Entries per diary	Mean	45.7	48.6
	Median	29.0	30.5
Mean time per entry (Seconds)		20.3	31.0
Quality of data entered		**Blaise**	**IPS**
Number of entries checked	Items	1891	461
Proportion of total entries	Percent	47.0%	17.6%
Missing items		0.42%	0.87%
Incorrect amount entered		0.63%	0.65%
Incorrect code selected		2.01%	4.99%
Incorrect description selected (correct code)		0.37%	0.00%
Incorrect day selected		(b) 1.75%	1.08%
Incorrect diary key entered		0.00%	(b) 12.15%
Other errors		0.05%	0.43%
Total errors		5.25%	20.17%
Estimated errors in production system (b)		4.56%	8.02%
IT Infrastructure Load		**Blaise**	**IPS**
Total UNIX load		N/A	262.73
(CPU seconds / UPUs)			49.26
Total Banyan server load (Requests)		245,106	N/A
Network load (Bits per second)	Mean	22,524	23,941
	Median	7,501	17,597
Total disk storage (Bytes)		1,401,022	20,541,604
IT Costs		**Blaise**	**IPS**
Total UNIX prime UPU (Dollars)		N/A	22.17
Total Banyan prime requests (Dollars)		7.35	N/A
Total disk storage (Dollars per month)		0.47	6.86

UNIX Prime UPU (Dollars per diary)	N/A	0.4263
Banyan prime requests (Dollars per diary)	0.0836	N/A
Disk storage (Dollars per diary per month)	0.0053	0.1319
UNIX prime UPU (Dollars per entry)	N/A	0.0089
Banyan prime requests (Dollars per entry)	0.0018	N/A
Disk storage (Dollars per entry per month)	0.0001	0.0027
Limitations	**Blaise**	**IPS**
Maximum number of users on UNIX server	N/A	> 50
Maximum number of users on Banyan server	> 50	N/A
Maximum number of users on network cable	> 100	> 100

(a) Due to the small scale of the test, the results should be taken as only being indicative of the real differences, which might be found in production systems. (b) Some errors in the prototype systems could be eliminated or reduced in a production system.

Despite the small size of the test, the results indicated that Blaise would cost significantly less to use for diary data entry than IPS. Blaise was expected to require up to 33% less staff resources (over the full 12 months of coding) and up to 50% less computing resources. It should be noted, that both systems were early prototypes and the performance of both systems would be expected to improve with further development. On the other hand, given that the differences were so great, it was felt that further testing was unlikely to change the outcome. There was also limited funding available for further testing.
The comments of coding staff supported the outcome and identified some other advantages in the Blaise system. These include:

- trigram coding was found to be more useful than the alphabetical lookup list used in IPS;
- immediate application of range edits on expenditure amounts (based on the commodity code) was preferable to edits being applied on a page of entries at a time (as was done in IPS);
- the parallel block feature provided a convenient and quick way to switch between sections of the form.

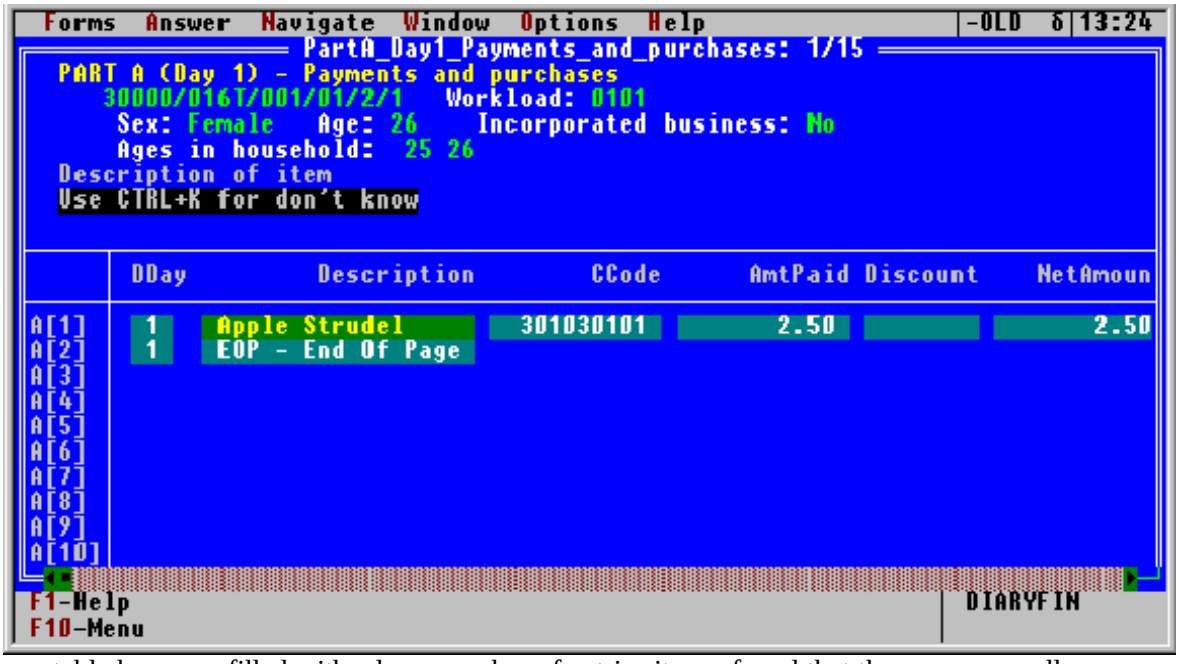
The decision to use Blaise for diary capture and coding was not influenced by the fact that the other HES questionnaires were to be collected using Blaise based CAI. While this may be seen as relevant, it was not considered to be critical because, apart from matching up diaries with particular respondents to ensure complete coverage, there is little information on the main HES questionnaires that is needed during diary processing. The small amount of information that is useful, such as age, sex, whether in business, could be exported to the diary system using ASCII files. Nevertheless, the decision to use Blaise, did have some benefits because there was already a Blaise based Office Management System available which could be modified to provide some of the management functionality that was required for the diary system.

5. Design of the diary instrument

A typical diary entry consists of a description of goods purchased and an amount spent. Although there were no plans to analyse the data by day, a day code (1 to 7 for each day of the week) was added to each entry to help with checking of those entries back to the actual diary, if required. Depending on the type of expenditure being recorded there were some additional fields to be completed by the respondent such as the amount of discount received, or the amount of an expense which related to business rather than private use.
Each diary item description was classified to a commodity code list using the Blaise trigram search method on an external file. A separate external file was also used to provide the tolerance levels for edits against each commodity code to ensure that the amount paid was within reasonable limits.
Because of the general consistency of the entries and a desire to make the entry form similar to the paper form, the logical Blaise element to capture the expenditure diary information is a table (containing rows of the same type of entry). Different tables were devised for the different sections of the diary and then arranged as a series of 13 parallel blocks. As mentioned earlier, the use of parallel blocks made it easy for

the coding staff to navigate to a particular section before entering data. A sample table of the diary entry screen is shown Figure 3.

Figure 3. Sample screen of diary entry for payments and purchases



Once a table becomes filled with a large number of entries it was found that there was a small deterioration in performance associated with the internal checking (of the rules) that Blaise does as each entry is added. Since this deterioration in performance is more noticeable with large tables, it was decided to have a separate parallel block for each day of the week. The largest table was then kept to 150 lines rather than the 500 or so lines that may be needed if all days were coded in the same table. Separate parallel blocks for each day of the week also save unnecessary keystrokes by entering the day code automatically in each case.

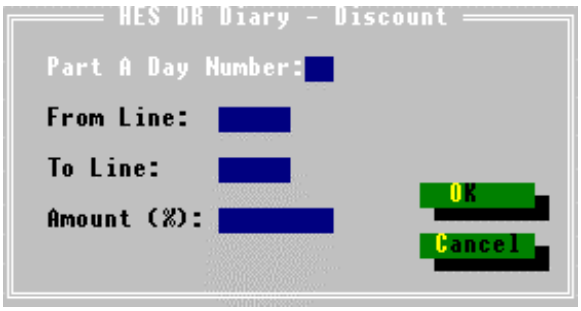
To remind the coder of the details of the diary that is being coded, the record identifiers and basic demographics (sex, age, summary of family members) were added to each screen through the label on the field defining the block. In that way, the respondent information is displayed constantly throughout the instrument.

To assist in defining the completeness of a diary, coding staff are required to enter "EOP - End of page" into the last entry of each parallel block when they have finished coding the corresponding entries (see Figure 3 for an example of such an entry). For blocks which require the entry of day codes, a day code of "0" (zero) is an alternative way of indicating that no further entries are required for a that block. When the diary is closed, a Manipula subroutine then examines each diary entry to locate "EOP" or Day zero codes as well as the presence of "QUERY" references (see Query resolution communication in section 6) to determine the status of coding for that diary and marks a field in the record with the corresponding result. The status of a diary record can then be used to control which other processes may be used on it. For example, only "completed" diaries can be exported for further processing.

A special feature of the diary instrument is the ability to "switch off" the discount column in the tables of general expense items and thereby reduce the keystrokes required for most entries. This was done through the use of an "Edit discount" field in the main block of the instrument which could be set by the coder to "Yes" to enable the discounts to be entered or "No" to skip the discount column. The discount column can also be "switched on" at any time by navigating to the main block and changing the "Edit discount" field accordingly. To assist the coder in applying a discount to a series of consecutive entries, such as might be applied for a staff discount at a grocery store, a small Manipula utility was written that uses the line references for a series of entries to be discounted (see figure 4). This utility can be called from the

Maniplus interface and asks the coder for the line references to which the discount is to be applied (for a particular diary record and a particular day).

Figure 4. Dialog screen for discount details to be applied



6. Communication between the diary system and other facilities

The decision to use Blaise for the data capture and coding of diaries created the issue of communication between these facilities and the Notes-based diary management facilities.

The Notes-based Diary Tracking facility needed to be provided with regular updates of the coding operations so that progress could be monitored daily. There also needed to be a way that problems with diary coding could be "notified" to the Query resolution facility for resolution. Separate solutions were developed for each of the situations mentioned.

Diary Tracking communication

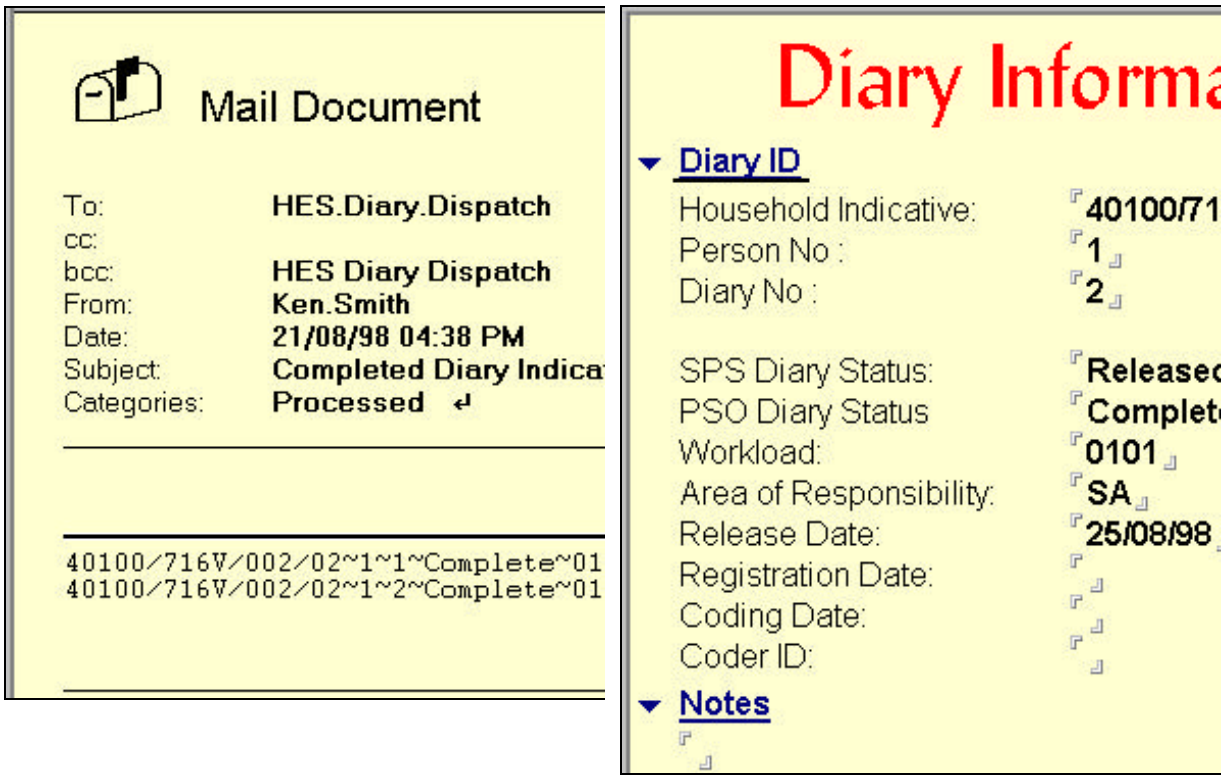
The Diary Tracking facility is notified of coding progress through Email messages which are generated at the end of each coding session. The text of the message contains a log file written by a Manipula procedure which is activated whenever a diary is completed (as determined by the status checking subroutine mentioned in section 5). The entry in the log contains the record indicative, date, time, ID of the coder and the status of the diary. A extract of the Manipula which writes to the log file is shown at Figure 5. Once an entry is written to the log the record is then flagged as having been "Emailed" to the Notes diary tracking system. This avoids the possibility that a diary could be notified more than once (unless the status has changed again).

Figure 5. Manipula code which writes each record (if changed) to the log file

```
OUTPUTFILE fNotesMail : mNotesFile ('', ASCII)
SETTINGS
   OPEN = No
   CONNECT = NO
   MAKENEWFILE = No
   TRAILINGSPACES = No

..............
MailID := Households.CaseID.PSU + '/' +
Households.CaseID.BlockChk + '/' +
Households.CaseID.Dwelling + '/' +
Households.CaseID.Household + '~' +
TempCt + '~' + DiaryCount

IF ((Households.OfficeFields.Diary1MailSent[aCount] = EMPTY) OR
(Households.OfficeFields.Diary1MailSent[aCount] = 0)) THEN
   IF (Diaries.DiaryStatus = Done) THEN
      fNotesMail.line := MailID + '~Coded~'
      + datetostr(sysdate) + '~'
      + Diaries.CoderID
      fNotesMail.WRITE
      aSendMail := 1
           Households.OfficeFields.Diary1MailSent[aCount] := 1
   ELSEIF (Diaries.DiaryStatus = Uncodable) THEN
      fNotesMail.line := MailID + '~' + Coding.DiaryStatus + '~'
          + datetostr(sysdate) + '~' + Diaries.CoderID
      fNotesMail.WRITE
      aSendMail := 1
      Households.OfficeFields.Diary1MailSent[aCount] := 1
   ENDIF
ENDIF

PROCEDURE ProcWriteMail
   fNotesMail.CLOSE
   IF aSendMail = 1 THEN
      Res := RUN('L:\utils\mailsend\mailsend '
       + '"HES Diary Dispatch" "Completed Diary Indicatives" "/'
       + aNotesFileName + '"')
   ENDIF
ENDPROCEDURE
```

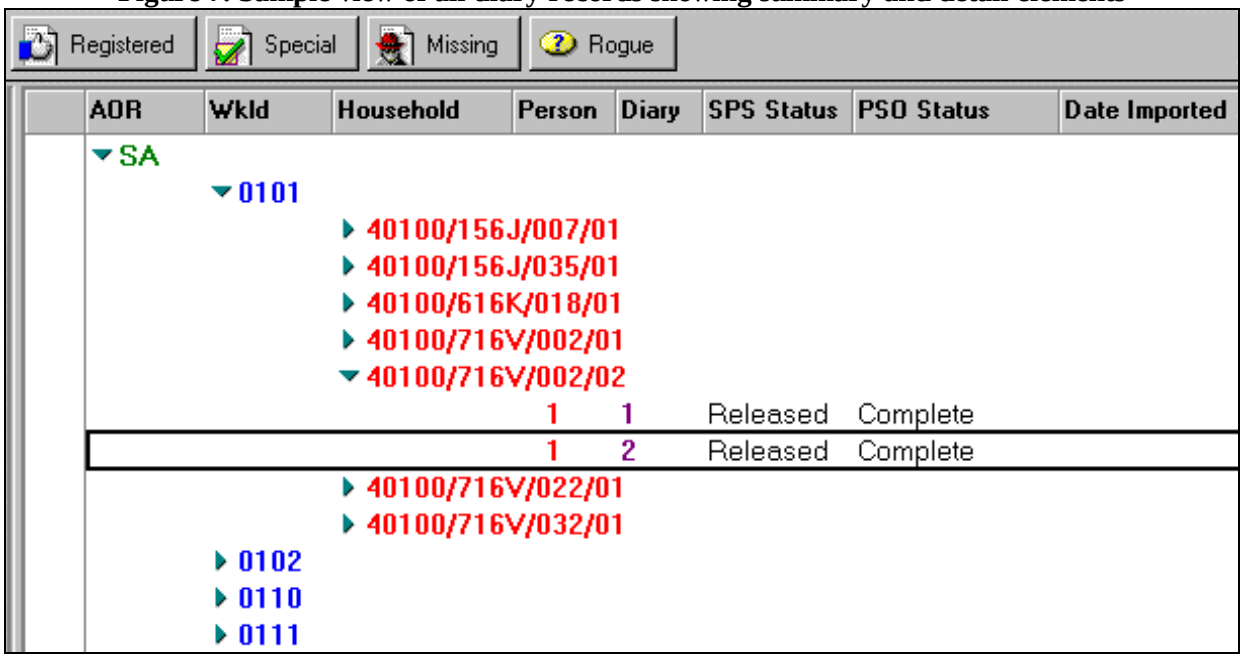
The "sending" is carried out by an ABS developed windows console application which is "run" by the Manipula when the coding session is completed. When the message is received by the Diary Tracking facility it is processed to update the status of each diary involved. A sample of the generated message and the form which is created for each is shown in Figure 6.

Figure 6. Sample Email produced by the system and the form generated in the Diary Tracking facility



When the messages are collated they can be used to produce a variety of reports on the status of coding, by asking Notes to present the records in different "views" (see Figure 7 for sample view). From this view, various processes can be activated using the buttons provided.

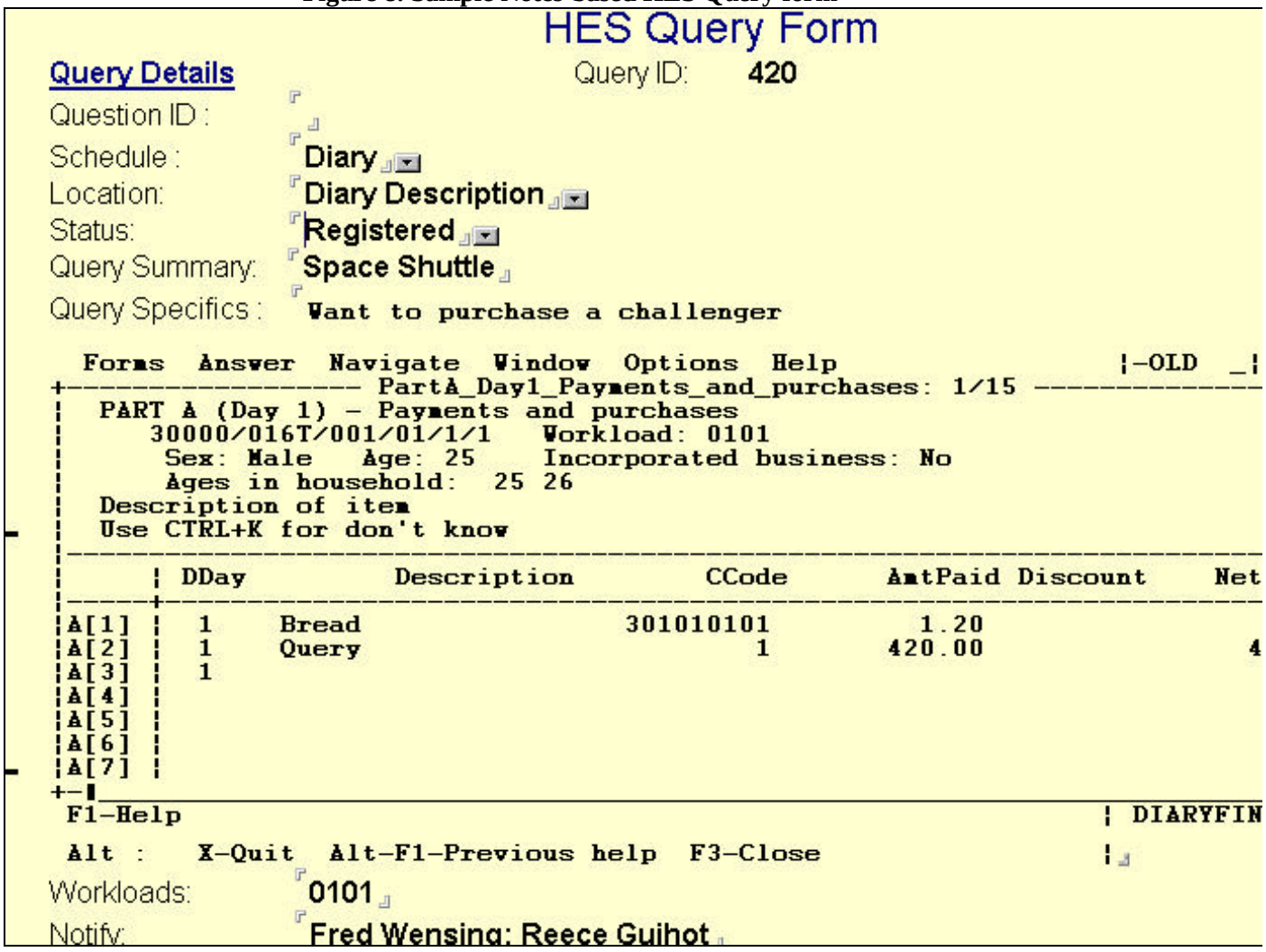
Figure 7. Sample view of all diary records showing summary and detail elements



Query resolution communication

When a problem diary or difficult coding instance is encountered, it is necessary for the coder to check the problems database and raise a "Query" which lodges the details of that query into the facility where a supervisor can find it and then resolve the problem. Given that the entry system is being operated from a DOS session within Windows 95 (and a Windows DLL cannot be used), it should be a simple matter of the coder switching to the Email system (using ALT-TAB) and typing a message or filling in a form. The problem with this solution was how to ensure that the details of the problem record were accurately recorded in the text of the message. The solution which was devised involves using the ALT-PRINT key combination to take a dump of the DOS screen and then paste it into a special field in the Windows based query form. By setting the font in the special field to a System font, the screen dump was converted to a simple text form. Figure 8 shows a sample of such a form after the DOS screen dump has been pasted into it. While the solution is not elegant, it does ensure that the information which was on screen for the coder is accurately copied to the query system.

Figure 8. Sample Notes-based HES Query form



Once the query has been registered, the coder then enters the registered query number into the problem diary. This is done by entering "QUERY" into the item column in the diary entry and entering the query number (number 420 for the example shown in Figure 8) into the amount column. The presence of this entry in the diary prevents it from being cleared for further processing. When the query has been resolved, the coder can then readily identify where to inse t the resolved entry.

7. Trigram coding issues

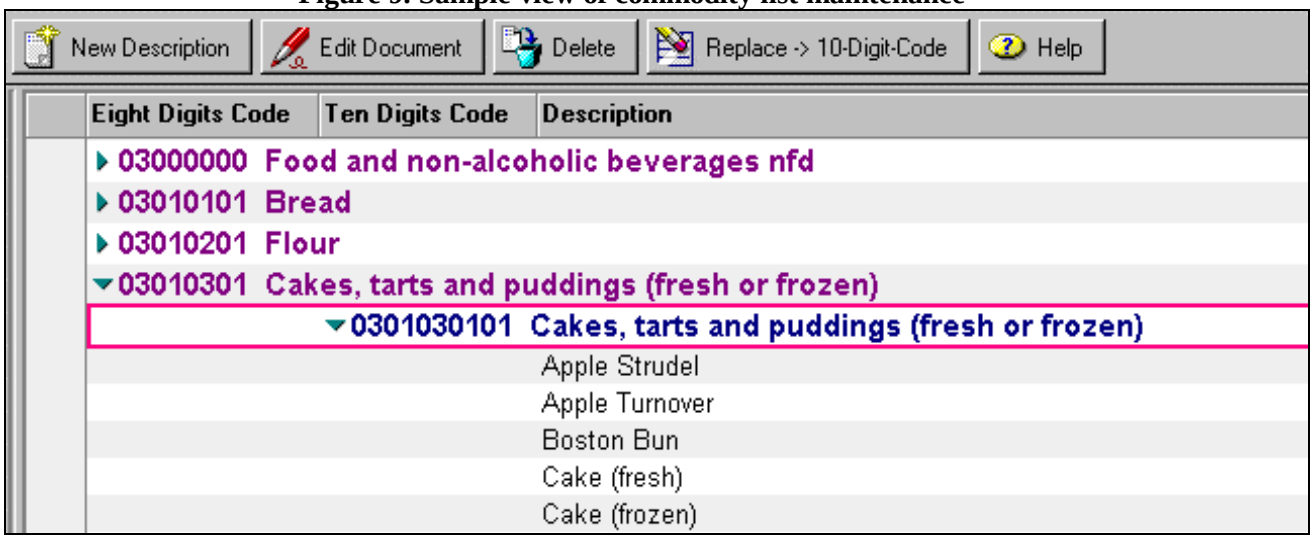
As mentioned previously, the descriptions of purchases were classified to a commodity code list using the trigram search method.

The code list consists of 625 codes arranged in a loosely structured 2-level framework and a lookup list consisting of over 6,300 separate descriptions. The trigram search method was considered to be appropriate for coding of purchases because of the large number of items involved and the way that the method returns a variety of possible entries when only a small number of letters are entered. It was certainly considered more appropriate than an alphabetical list.

Facilities were developed in a Lotus Notes database to assist with the display and maintenance of the coding list and the edit limits. As and when it was considered necessary, the updated list was exported from the database to an ASCII file which was then loaded into the Blaise system.

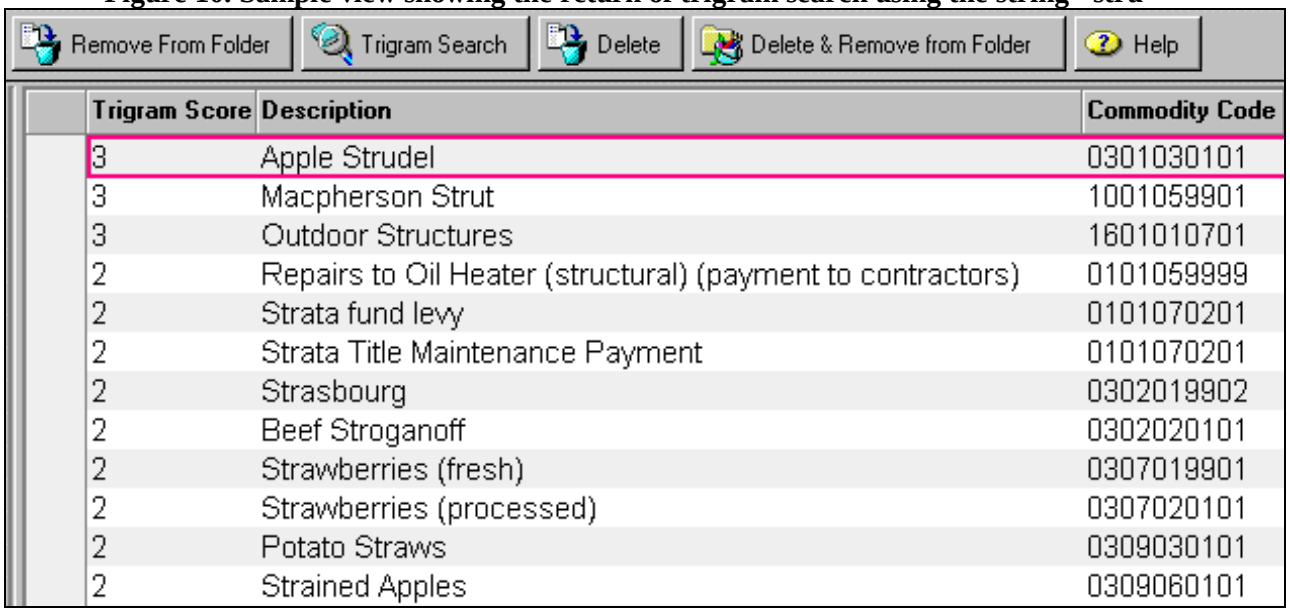
A Notes database was considered preferable to a Blaise maintenance utility because it could be readily accessed from the Windows desktop. The database also has the ability to present the coding list in a variety of "views" so that maintenance staff can readily examine which entries are coded to which category. The Notes facility also provided version control functionality, by keeping track of changes and retaining "deleted" entries. A sample view from the utility is shown in Figure 9.

Figure 9. Sample view of commodity list maintenance



In order to assist with maintenance of the coding list, a local Notes "agent" was developed to test the behaviour of the trigram method. This was done so that the various pick lists which come up when a search string is entered could be examined. The agent scores each entry in the database against the trigrams that are found in the search string and presents the results in a temporary view, ranked by the trigram score. The method was set up to replicate the way that trigram searching is done in Blaise. In that way any changes to the list could be immediately tested without having to export and load the data to a Blaise datamodel first. A similar "testing" facility is available from the main screen of the Blaise system to assist with query resolution.

Figure 10. Sample view showing the return of trigram search using the string "stru"



Trigram Score	Description	Commodity Code
3	Apple Strudel	0301030101
3	Macpherson Strut	1001059901
3	Outdoor Structures	1601010701
2	Repairs to Oil Heater (structural) (payment to contractors)	0101059999
2	Strata fund levy	0101070201
2	Strata Title Maintenance Payment	0101070201
2	Strasbourg	0302019902
2	Beef Stroganoff	0302020101
2	Strawberries (fresh)	0307019901
2	Strawberries (processed)	0307020101
2	Potato Straws	0309030101
2	Strained Apples	0309060101

Whenever the commodity list has been updated it is exported to the LAN for compilation into a Blaise datamodel for the diary coding system. The next time that a coder logs into the system he/she will then use the updated code list.

8. Verification of diary coding

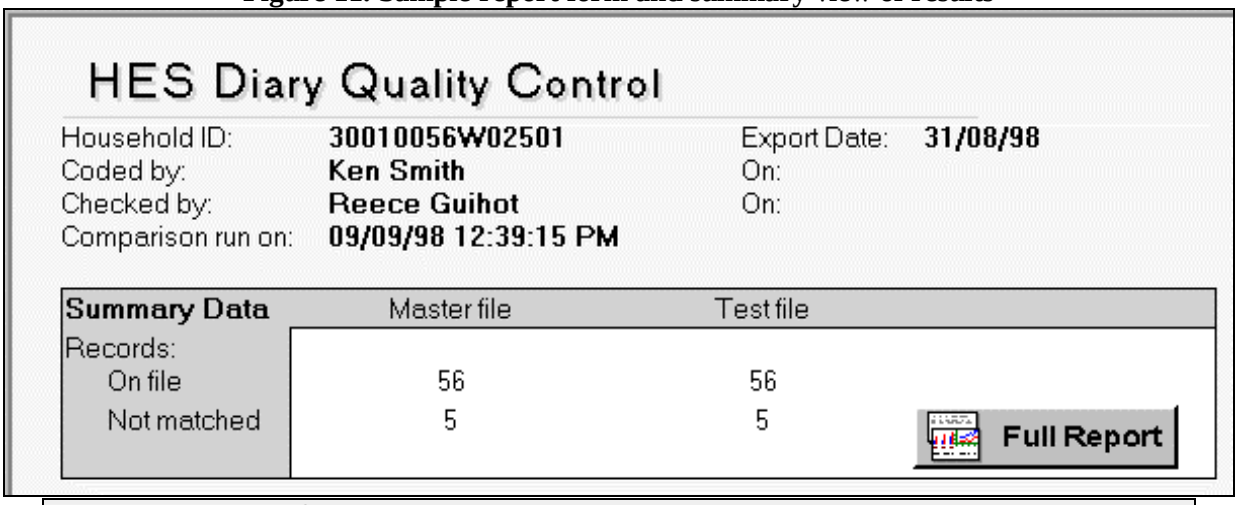
Ensuring and maintaining the overall quality of the coding is a very important aspect of the processing work. The high volume of coding to be done over a 12 month period means that systematic errors made by one or more coders can impact significantly on the quality of the final data. The ability to identify patterns of errors in the work of coders, for example, due to the misinterpretation of the coding rules, is an essential requirement of the diary coding system. To ensure that an adequate level of coding quality is maintained, a strategy has been developed which entails the check coding of a selection of diaries. Initially 100% of all diaries are check coded. For each coder, the level of checking drops to 1 in 5 households provided that the error rate is less than 10%, and a further drop to 1 in 8 households occurs once the error rate is less than 2%. The error rate is calculated to be the number of errors as a proportion of the total possible number of entries in a sample of diaries extracted from a single workload (about 60 diaries). The diaries to be checked are selected by applying the relevant skip interval continuously across all workloads. When the mismatch between original and checked diaries is less than 2% then the entries are considered acceptable and not changed. When the mismatches are greater than 2%, they are assessed and the error rate determined. If the error rate is greater than 10% then the entire workload is re-coded by a different coder.

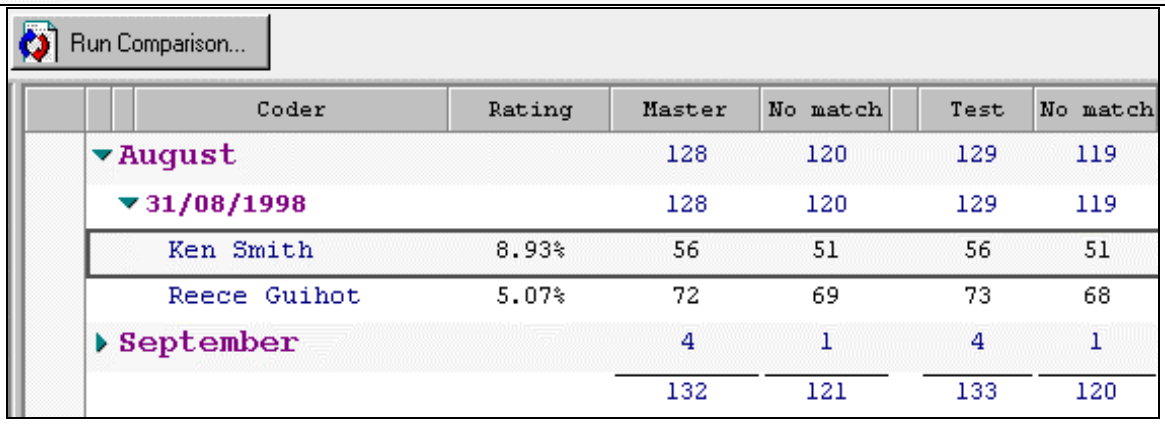
In building the checking facilities, it was initially considered having a parallel set of diary entries in the same instrument with the relevant path defined by whether the person was coding or checking. Under this parallel coding design it would be possible to identify each difference as it occurs. Although some tests of this design were made, it proved difficult to keep the parallel entries in the record while trying to make the behaviour of the instrument appear the same for both operations. In addition there were concerns about the check coder being influenced by existing entries whenever a difference was notified and about the necessity to carry a duplicate set of fields in the record. Consequently it was decided that check coding would be done using a duplicate set of records which would be checked against each other later.

The Blaise based diary coding system was enhanced to enable the generation of duplicate records (selected according to the relevant skip interval) for check coding purposes and access them from the same interface. The functionality associated with the check coding processes was then identical to the original

coding processes. No direct checks are made between the original diary and the check copy. Comparison of the two coded diaries is done later.
In the same way as the Diary Tracking facility, it was a preferred requirement of the checking system that the results of the check coding were supplied to a Notes based utility where office staff could readily access them. The Blaise diary data and the corresponding check data is exported to ASCII files for examination via a SAS program which matches all the diary entries and identifies the differences. The summary results are written by the SAS program directly into a report document in the Notes database with the detailed listing of discrepancies in each case accessible via a "button" in the document. Figure 11 shows a sample report form and summary view of the check coding results with calculated error rates. The choice of SAS in this process was partly a result of the requirement to write directly into the Notes database and partly a result of the skills of available staff.

Figure 11. Sample report form and summary view of results





9. Conclusions

The HES diary coding system, as developed at the ABS, illustrates how it is possible to integrate Blaise DOS-based software with Windows-based facilities through innovative use of Email, screen dumps and exporting data to ASCII. Mixing Blaise and Windows-based software provides the opportunity to exploit the advantages of each. In the case of Blaise, the data entry functions and relative efficiency are exploited, whereas in Notes the Windows presentation of data and reports is exploited. While a Windows version of Blaise should make integration somewhat easier it should not preclude using other software where it provides useful functionality.
Another conclusion from the experience with this system development is that it is worthwhile conducting some performance tests, even on a small scale, before committing to a particular solution. In this case, the

comparative tests identified considerable efficiencies to be gained from the use of Blaise for those functions that it is good at.

10. Acknowledgments

The authors would like to acknowledge the work of Ken Smith, Reece Guihot and Gary Edwards who designed and built the systems described in this paper. Acknowledgment is also given to Mano Georgopoulos who contributed significantly to the design of the systems and conducted the comparative analysis of Blaise and IPS.

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Section C. Design, Testing and Documentation

Producing an error-free CAI instrument -- Is it possible?

Maureen Kelly, Office for National Statistics (UK)

1. Introduction

The data collected by Social Survey Division (SSD/ONS) are published in high profile Government statistics (for example the Retail Price Index, unemployment statistics). They are widely used by public policy makers. It is therefore essential that the data are as accurate as possible. Computer Assisted Interviewing (CAI) has had a major impact in improving data quality in our surveys. Implementation of a survey instrument is more controlled. For example, interviewer errors in following the correct routing in complex instruments have been eliminated.

These improvements, and the quality of the resulting statistics, depend on the accurate design of the survey instrument. Moreover, CAI has allowed much more complex routing to be designed, since the interviewer is no longer required to work it out on the spot. CAI instruments can include edit checks. As a result, CAI instruments tend to be more complex than paper questionnaires.

Testing plays an essential part in reducing errors in CAI instruments. For large and complex surveys of the kind typical in public sector social research, the theoretical possibilities for testing are almost limitless. The challenge is to find ways of testing both thoroughly and cost-effectively. Surveys that are carried out continuously offer more opportunities to learn from testing than do *ad hoc* surveys. This paper will look at the problems encountered when trying to test the Blaise instruments used for continuous social surveys. The main example will be the U.K. Labour Force Survey (LFS).

An important aspect of producing error-free instruments is the way in which the CAI program is written. This paper will look at ways to structure and write Blaise programs so that errors are less likely to occur, and at ways to provide a basis for efficient testing.

Finally, the paper will look at the different problems encountered when developing and testing completely new instruments as compared with maintaining and amending instruments already in use.

2. Time and resources

The major constraints on the thorough testing of Blaise instruments are the amounts of time and resources that are available for testing. As the theoretical possibilities for testing are almost limitless, if an organisation had infinite resources and no timetables to meet, each instrument could be tested at leisure until it was perfect. In practice, ~~A~~as development timetables are short~~en~~ and survey managers tend to economise on the timetable elements with most elasticity, such as~~to over to~~ testing. However, it could be argued that testing is particularly important~~ when it is probably more essential (as~~ when the instruments

~~may~~ have been written under stringent timetable~~increased~~ pressure that makes them~~and therefore may be more~~ error-prone.~~)~~

Another problem is the increased flexibility that an electronic instrument gives~~n~~ to clients to change the questionnaire specification at late notice~~;~~. It is technically feasible, if not advisable, to make changes right up to~~ usually just before~~ the beginning of fieldwork. The later any changes are made, the less time there is to test them. For example, ~~T~~the LFS was market tested in 1995, after which all aspects of the timetable were accelerated, including the crucial development phase~~;~~ for writing and testing the Blaise instrument. The new contract also allows the clients to make changes to the questionnaire up to two weeks before fieldwork begins. ~~The later any changes are made, the less time we have to test them.~~

Given the constraints on both time and money, whatever testing that is carried out needs to be organised and prioritised in a such a way as to ensure the instrument is as correct as possible whilst making the most efficient use of people's time.

3. The testing process

There are two major strands to efficient testing:

- ensuring that there is a well-structured and systematic procedure for testing the instruments; and
- good management of the testers and the testing process.

~~- good organisation of the testing process, that is, deciding who is doing the testing and making the best use of their time; and~~

~~? ensuring the testers are testing the instruments in a well-structured and systematic way.~~

~~-~~The two strands are inter-related; how the testing can be carried out is, to some extent, dependent on who will be doing the testing.

There are several distinct testing phases that a CAI instrument should pass through before it is used as an interviewing tool. Each phase is important, but~~however~~ on its~~their~~ own it~~ they~~ would not constitute a thorough test of an instrument.

When a new version of an existing instrument is required, an author makes the necessary changes to the CAI programs. The author usually does the first phase of testing; testing the amendments they have made as they go along. This is seldom done ~~is not usually~~ in a ~~very~~ systematic way, as ~~the~~ authors tend~~s~~ to concentrate on the changes they have just made. ~~and~~Authors often fail to~~does not~~ check if there are any adverse~~that the~~ effects of the changes on other ~~have not adversely affected another~~ parts of the program.

Once ~~all~~ the author is satisfied that all the changes have been made, a second stage of testing is required. ~~which~~This is carried out on a completed instrument. It~~This stage~~ is the most important stage and is discussed in further detail below in Section 3.1.

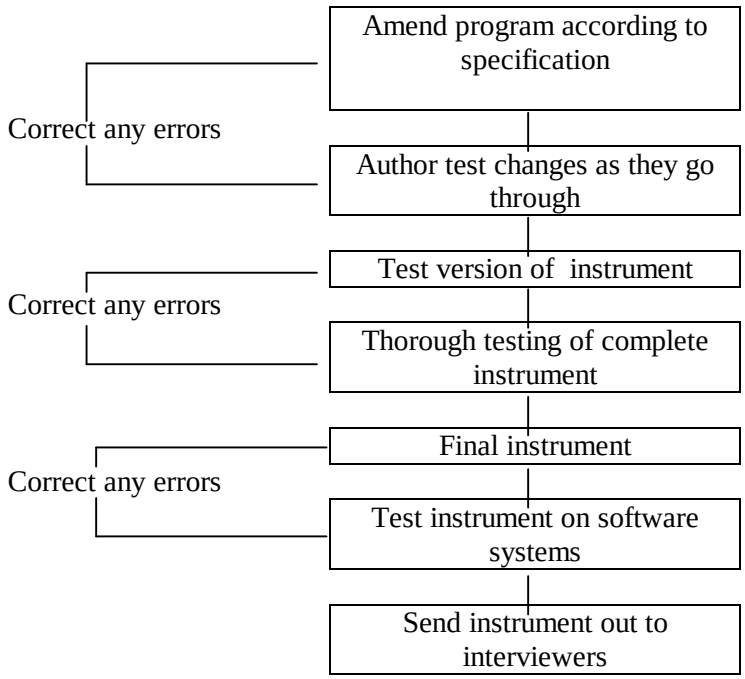
~~All t~~These stages are iterative.~~;~~ ~~i~~If errors are found, the CAI program is amended.~~;~~ ~~t~~The instrument is recompiled and the new instrument is re-tested in the same way. This process is repeated until all the errors have been corrected.

Finally, once ~~all~~ the testing of the instrument is complete, the interface between the final instrument and the software~~operating~~ systems used by the interviewers need to be tested. Parts of the instrument may use~~rely utilise~~ external information or programs (for example, DOS environment variables, Dynamic Link Libraries and external Blaise files and libraries). In addition, the interviewer's systems may need to use information written out in ASCII from the Blaise instrument. (The need for this is reduced in organisations that use Maniplus for case management.)~~, writing out of ASCII files).~~ For the LFS, there are two interviewers' systems with interfaces to Blaise:

- ~~-~~Casebook, used by the face-to-face interviewers on their laptops, and
- ~~-~~a CATI~~PC based~~ Call Scheduling system for the telephone interviewers.

Once the testing is complete, the instrument can be made available to the interviewers, to conduct interviews. Figure 1 shows a summary of the testing process.

Figure 1



3.1 Structured testing of the complete instrument

Thorough testing requires independent testers. There are two common methods of testing instruments: entering data into the instrument; or examining the source code. Only someone who can read CAI programs can do the latter. In~~Within~~ SSD/ONS, many of the independent testers are unfamiliar with Blaise programs. Therefore most~~the majority of the~~ testing is done interactively by inputting data into the instrument. Examination of the source code is usually only used when to trying to correct a ~~identified~~ problem that has been identified by the first method~~with the code~~. Moreover, the only way to test layouts, question wo~~o~~rding and text substitution is by looking at the instruments on screen.

An independent specification, that is, one that has not been generated by the CAI program itself, is a necessary tool for testing. Firstly, the author~~s~~ needs it to make all the necessary changes. Secondly the

independent testers should use it to check thatese the changes have implemented correctly. Theis specification needs to be understandable to testers unfamiliar with the CAI programs. For this reason, many survey researchers use flow charts to show the routing of the instrument. Survey researchers do not always have formal specifications from customers. Customers sometimes state their requirements for questions in general terms. The researcher then has to translate these requirements into a specification and routing for the CAI program.

Tests ofWhen testing routing, checks and signals should examine all possible combinations of data should be tested. It is important to check it is important that the 'negatives' are tested as well as the 'positives'. That is, that the correct sub-groups of people are asked the question and that people not in the specified group are not asked the question.,, It is, of course, far worse to collect too little information than too much. If too much is collected, the data can be edited after the interview. However, asking respondents questions which do not apply to them is to be avoided if possible, to reduce respondent burden and costs, and avoid disruption of the flow of the interview would be affected as respondents are asked questions that are not applicable to them.

The 'negative' testing is always more time consuming then testing positives. There are usually more combinations of routing that result in the question not being asked than being asked.

Example 1

Five questions QA, QB, QC, QD and QE have the answer categories 'yes' and 'no' and the routing is as follows:

```
QA
IF (QA = YES) THEN
   QB
    IF (QB = YES) THEN
         QC
    ENDIF
ENDIF
QD
IF (QA = YES AND QD = YES) THEN
   QE
ENDIF
```

To test QB, four responses to QA need to be tested: yes, no, don't know (Ctrl+K) and Refusal (Ctrl+R). These give the following results:

QA	***QB***
Yes	Asked
No	Not Asked
Don't Know (Ctrl+K)	Not Asked
Refusal (Ctrl+R)	Not Asked

It is important to test that the correct question attributes have been used and what effect the missing values (Ctrl+R, Ctrl+K) have on the routing of the instrument. They are sometimes overlooked, but they can have an affect on the routing. In this example, it is fairly obvious that the Don't Know and Refusal will not be

routed to QB. In others it is not so clear.

As the routing gets more complex, the number of different combinations that need to be tested increases. The routing toof QE involves two variables: QA and QD. Each question has four possible answers, resulting in 16 combinations. Only one of them should resulting in the question being asked:

QA	QD	QE
Yes	Yes	Asked
Yes	No	Not Asked
Yes	Ctrl+K	Not Asked
Yes	Ctrl+R	Not Asked
No	Yes	Not Asked
No	No	Not Asked
No	Ctrl+K	Not Asked
No	Ctrl+R	Not Asked
Ctrl+K	Yes	Not Asked
Ctrl+K	No	Not Asked
Ctrl+K	Ctrl+K	Not Asked
Ctrl+K	Ctrl+R	Not Asked
Ctrl+R	Yes	Not Asked
Ctrl+R	No	Not Asked
Ctrl+R	Ctrl+K	Not Asked
Ctrl+R	Ctrl+R	Not Asked

12 out of the 16 combinations involve the Ctrl+K and Ctrl+R categories. In many cases the Don't Knows and Refusals are treated in the same way. To save time, ~~test~~ in most cases it would be sufficient to test either Ctrl+K or Ctrl+R at each question but not both. In the example given above this reduces the number of combination from sixteen to nine. Note that~~If a question has different attributes, for example~~ when there is an explicit 'don't~~k~~ know' response category ~~and therefore~~ the attribute NODK is often attached to avoid giving the interviewer two 'don't know' options. A question like this should be checked to make sure Ctrl+K cannot be entered. If the question is used in the routing for other questions the routing of Ctrl+R has to be tested.

Particular attention should be paid when NOT conditions are used in routing. It is may be unclear what should be routed to the question, and particularly easy to overlook the routing for the missing values.

Once the routing for QB has been satisfactorily tested, then QC can be tested, and so on. The nesting of the questions within a block facilitates this testing process. If one question relies totally on the information from a preceding question that has already been tested, then you do not need to go back and retest the routing to the preceding question. For example, the routing of QC relies totally on QB. Once the routing to QB has been tested and found to be correct, QC can be tested without the need to go back and retest the routing to QB.

In an ideal world the routing to all the questions within the instruments would be tested. This would ~~usually~~ take more time than is ~~usually~~ available for testing. The testing can be separated into several stages so that the instrumeem~~m~~nt is thoroughly tested without having to test every single question:

- testing the changes made;
- testing the remainder of the instrument;
- overall testing of the instrument.

~~? testing late changes.~~

~~T~~3.1.1 Testing changes

The main focus of testing amended instruments for continuous surveys is to ensure that all the necessary changes have been implemented correctly. There are different types of~~different~~ changes that can be made to an instrument, all of which need to be tested~~–~~:

- new questions introduced;
- old questions removed;
- changes to routing;
- changes to wording – question text and answer categories;
- changes to answer ranges;
- new/amended checks and signals;
- new/amended text substitution;
- changes to computations;
- changes to layout;
- changes to attributes (e.g. EMPTY, DON'T KNOW, REFUSAL)
- changes to parameters;
- updating of coding files.

In some instances, the changes may fall into more than one category. For example, ~~. W~~when adding a new question, all the wording, routing and layout need to be checked. Changing the routing to an existing question may also result in checks, signals and~~,~~ text substitution being amended. Adding an extra answer category to a question may also require a layout change to ensure that it fits on the same screen as the original answer categories.

Routing, checks, signals, computations and text substitution can be checked at the same time together as they all appear and are affected by the RULES paragraph of the program. Similarly~~In a similar way~~, question wording, layout of the question text and on-screen instructions can be checked together.

When testing changes, a 'test' version of the instrument can be used. This shows fields and auxfields that would normally be hidden in order that computations can be easily tested. The author has to remember to hide these fields before the instrument is finalised. It is usually a good idea to make testers aware that some fields appear which they will not see in the final version.

3.1.2 Testing the remainder of the instrument

Once all the code for the intentional changes to the instrument has~~ve~~ been tested, the rema~~am~~inder of the instrument needs to be tested to ensure that none of the new code has~~changes have~~ adversely affected the conditions for~~routing to~~ any other questions~~variables~~, checks or computations. The hierarchical block structure of the CAI program and the nesting of questions within these blocks facilitate this process.

If the routing to any questions, ~~or~~ checks~~,~~ or computations~~,~~ remains as before~~have not changed~~ but the conditions for these items~~y use~~ include variables for which~~where~~ the~~y~~ routing has been changed, then these items too should be tested. ~~This includes both questions within the same block as the amended question, and in other blocks.{tm – I don't understand the need for the last sentence}~~

If the routing to a particular question is amended, the routing to all the subsequent questions within the same block should be tested. Simple mistakes such as putting an ENDIF in the wrong place can cause ramifications throughout the routing of the remainder of the program.

Example 2

The specification for four questions is as follows and an amendment needs to be made to QB:

QA – ask everyone

QB – ask only if QA = YES (previous routing – ask everyone)
QC – ask everyone
QD – ask only if QC = YES

The routing was written as:

IF QA = YES THEN
QB
QC
ENDIF
IF QC = YES THEN
QD
ENDIF

The routing to QB (the IF condition) is correct. The ENDIF that should come after QB was placed incorrectly after QC. Therefore the routing to QC is incorrect. Even though the routing to QD is written correctly, not all the people who should be asked QD are routed to it. The error in the routing to QC is carried through to QD. After testing the change to QB, there still needs to be a test of routing to QC and QD if the tester is to find the error.

~~If a block has not been amended~~Sometimes a whole block is unaffected by the current revision. No code within it needs to be changed. None of the conditions for any of its component questions invokes amended questions in other blocks. The routing to unamended blocks still need to be tested. In the above example, the questions QC and QD could relate to blocks of questions. The error would then affect two whole blocks of questions.

To test the routing to a block, some questions within that block need to be tested. Only certain questions need to be tested: the first question in the block, any other questions at the highest level within the block (that is, with no IF/ENDIF statements), and questions with references to questions outside the block. ~~-~~The nesting of questions within a block m~~n~~eans that most questions are dependent only on answers to previous questions within that block. ~~, and t~~O~~herefore o~~nly a few questions ~~that~~ have references to questions outside that block. ~~Testing the routing to all the 'un-nested' questions is sufficient to test that the whole block is correct. 'Un-nested' questions are the first question in the block, those at the highest level within the block (with no IF/ENDIF statements), and those with references to questions outside the block. The routing within the block can be assumed to be correct before any amendments were made to the program. The~~

~~CAI programs used before the amendments are usually the ones used to create the instruments that are currently in the field.~~ Testing the ~~'un-nested'~~ first and highest level questions ensures that the routing to the block is correct. Testing questions with references to questions outside the block ensures ~~and~~ that the transfer of information between blocks is correct. Testing the routing to all the 'un-nested' questions is sufficient to test that the whole block is correct. This process should be repeated for each block within the program, so the whole instrument is tested.

3.1.3 Overall testing of the instrument

Once the testers are satisfied with the changes to ~~all the necessary~~ individual questions ~~have been satisfactorily tested~~, they should carry out more general testing of the instrument ~~questionnaireis should be carried out~~. Many surveys, including the LFS, do this by entering ~~On the LFS, they~~ Imaginary households ~~are created and enter~~ data ~~enter~~ for imaginary test household~~sed into the instrument~~ to check that the questions appear as expected. The LFS questionnaire is made up of a household section followed by ~~be and~~ individual ~~a series of~~ interviews for each person in the household. Imaginary ~~Several~~respondents are created to reflect the important sub-groups the LFS is trying to identify, such as~~. For example~~: full time employees; full-time students with and without a part-time job; housewives, not working and looking after small children; retired old age pensioners; and unemployed people looking for work.

The~~is~~ next phase of ~~is followed by~~ testing is for different types of households and the full range of ~~testing the various~~ household outcomes. As with testing 'negative' routing, it is important to check ~~that~~ the Blaise code applying to ineligible and non-responding households ~~are checked and are working correctly~~. Most of the testing concentrates on what occurs during an interview with ~~, and that~~ respondents ~~are asked the correct questions~~. Experience from the LFS has shown that interviewers can encounter serious problems, such as unresolvable check messages, if testers overlook cases where there is no respondent. ~~this part of the testing is overlooked.~~

Similar tests are appropriate for surveys of persons rather than households.

~~*{Tm - I'm not sure that this section adds anything*~~ *Late changes*

~~There are usually late changes made to the program just before it is finalised when there is no time to fully test the instrument again. Depending on what these changes are, it is may be advisable, but not essential, for another person to check the amendments. For example, if a spelling mistake is corrected it is probably not necessary to check it. However, if an important computation or piece of routing is changed, someone should check that the amendments are correct.}~~

3.2 Organisation of the testing process

3.2.1~~a)~~ Who should do the testing

In~~Within~~ SSD/ONS, the author of the Blaise instrument ~~usually~~ has overall responsibility for ensur~~test~~ing that the instrument ~~to ensure that it~~ delivers what is expected. Although the author is usually involved in the testing it is not usual, or advisable, that they alone should ~~author solely~~ test~~ed~~ the questionnaire ~~alone~~.

Authors can sometimes let errors slip through as they can suffer from 'seeing what is expected' rather than what is there. Therefore other people should be involved in the testing: other researchers working on the

project, administration or field staff, and interviewers. The number of people and amount of time available for testing will depend upon the project and the resources available. On the LFS, at least one other researcher and ~~alongside~~ a number of ~~telephone~~ interviewers from the CATI unit test the instrument. Since the unit is centralised, it is easy to discuss the instrument with these experienced interviewers and costs are low. Testing by interviewers, in addition to other testing, is the norm for CAI instruments in SSD/ONS.

Provided there is careful management,~~Usually~~ the more people who look at the questionnaire the better. For example if there is only one day set aside for testing, it would probably be better to use two people to look at it for half a day each, rather than one person for a full day. This has the advantage that one person may pick up~~you~~ an error the other has ~~accidentally~~ missed. ~~Also, t~~Testing questionnaires is a laborious and dull task, so the time any one ~~and~~ tester spends on the task should be short.~~s are likely to get bored, and therefore may be more likely to miss errors if they have to test the instrument for a long period of time. {Tm - I'm not clear from this para and the next if we want to check each other's work or not - the paras seem to give conflicting advice. I think one of the paras has to go.}~~

Only a moderate amount of duplication of testing amongst testers is necessary. Poorly organised testing leads to excessive duplication can occur which is a waste of valuable time and resources. ~~The more people involved in the testing, the more likely there is to be a unnecessary amount of duplication of effort, with the testers testing the same part of the questionnaire at the same time and therefore finding the same errors. Although a moderate amount of duplication is inevitable and necessary, so that more than one person has tested each part of the questionnaire, too much is just a waste of time and resources.~~

~~In the past, w~~When ~~the~~ LFS interviewers first became involved in testing~~ed~~ the questionnaire, they were given ~~very~~ little guidance or co-ordination ~~as to how they should test the questionnaire~~. Unsurprisingly, they all tended to start ~~This resulted in the interviewers usually starting to test the questionnaire~~ at the beginning and duplicate their efforts and findings. ~~, and all coming across the same errors. It also meant that M~~more time was spent on~~testing~~ the beginning of the questionnaire than on its later sections~~, finding the errors which left less time for testing the latter parts of the questionnaire~~.

One way the LFS sought to reduce the amount of duplication was to split the testing of the changes into sections. The testers ~~esters~~ are made responsible for testing individual sections, such as household information, employment details, job search activities, education, administration etc. The work is organised so that each section is tested by at least two people. Splitting the questionnaire into sections also made the task more manageable for the testers, some of whom admitted that they felt daunted by having to test the entire questionnaire. The~~is~~ result~~s~~ of giving the testers ownership of a clearly defined and manageable task is that ~~in~~ each section of the questionnaire is~~, being~~ thoroughly tested. ~~In~~ In the previous situation, a~~rather than~~ number of people ~~superficially~~ check~~ed~~ing the whole questionnai~~ia~~re rather superficially.

3.2.2~~b)~~ Documentation

Testers need documentation so that they know what to test. As well as the independent questionnaire specification, the LFS testers also found the following documents useful:

- T~~T~~he specification for the previous version of the instrument. As they were testing the amendments to an existing questionnaire, they found it useful to be able to compare the two specifications, as well as the instruments.
- A list of all the changes made to the instrument, which they would have to test.

- A list of all the other questions that needed to be tested (see 3.1.2 – Structured testing. Testing the remainder of the instrument).
- A structure diagram of the instrument. Many of the testers are unfamiliar with Blaise and the block structure of the instrument. They found a structure diagram useful to see how all the sections fit together, which is not always obvious from a paper specification.
- A set of test data ~~list~~ of imaginary respondents and households to test the whole instrument.

3.2.3~~c)~~ Communication

Good communication is essential for an efficient testing process. This includes communication amongst the testers and also between the testers and the program author. One problem identified by ~~with~~ the LFS CATI interviewers in their roles as testers is that they work fairly independently of each other. It is particularly difficult to share information across shifts. ~~, working on different shifts in the Telephone Unit.~~ One tester could discover a problem and inform the author, only to discover~~not realising~~ that another tester had already found it. Email was ~~usually~~ used to communicate between the author and the testers~~,~~. This ~~which~~ provided a useful record of the reported problems for the author, but not for the testers. To improve communication, a~~However, the testers also decided that a~~ log of the problems found was set up.~~would also be useful, which~~ It listed: a description of the problem, which variables it affected; which tester had found the problem; when it was found and when it was corrected.
The log was particularly important in recording when a problem had finally been corrected. ~~It was important to find out when the problem had been corrected as testers could spend a lot of time checking known errors before they have been corrected.~~ The testers usually get more than one version of the questionnaire to test: they test the original version and~~, they test it,~~ find some errors~~;~~ the author corrects the~~m~~ errors and produces~~gives them~~ another version. They~~y~~ interviewers then test the new version~~is~~ to see if the errors have been corrected. This process is continued until all the errors have been eliminat~~correct~~ed. However, there are some problems which are harder to solve than others, and it may be the case that the author has to ~~you~~ issue an interim version of the instrument, which only corrects some but not all of the reported problems. It is essential that the author communicates to the testers when the amended instruments are available to use and which problems have been corrected, otherwise vital testing time can be wasted.

3.2.4 Timetable

One of the major problems encountered when testing instruments is the time available for testing. It is important for all the people involved in the process to know when~~whne~~ the testing will take place, and how long they will have to test the instruments. This includes when they will get revised questionnaires. This will help the testers plan their work and make the most of the time available.

4. Good practice in questionnaire design

So far, this paper has focussed on the issues surrounding the problems of testing instruments after~~, once~~ they have been changed. Another important aspect of providing error-free instruments is trying to avoid producing the errors in the first place. There are many ways to improve instrument design. Two common examples may illustrate the point.

The simplest way to minimise error is to make as few changes as possible to a well-tested instrument. ~~Usually, the less changes that are made to a program the smaller the number of errors can occur. However, when testing instruments for continuous surveys the majority of the testing concentrates on ensuring the~~

changes have been implemented correctly. Even in these cases, the way in which the program is written can have an affect on the number of errors that are likely to occur. Before the LFS moved to Blaise III (in September 1996), there was a major revision of the program each quarter. Every year, About 10% of the instrument changed the similar changes were made to each quarter. The quarterly instruments were each as large as Blaise 2 could handle's questionnaire. When the LFS moved to Blaise III made itit was possible to create an annual questionnaire, which contained the routing for all four quarterly questionnaires. This consolidatedreduced the amendments made to the questionnaire into a single annual revision and thus reduced the potential for errors. On other surveys, Blaise III made it possible to consolidate previously separate household and individual instruments, resulting in similar improvements Now, only one major revision of the questionnaire is carried out each year.

Good design of routing is critical in reducing the scope for errors. Routing should be at the highest level possible.; If a particular condition applies to all the questions within a block, that condition should be used in the routing to the block rather than the routing to the questions within the block. This will reduce the number of questions that would need to be tested after all the intentional changes within a block have been tested (see 3.1.2 – Structured testing. Testing the remainder of the instrumentpart (b)). Also, dDuplication of routing at the two levels, which sometimes occurs under time pressures if the Blaise writer does not plan changes carefully, is particularly toshould be avoided. Not only is it inefficient, butas it is easier for errors to creep in later when one level is amended and the other is not.

It may be useful to create dDerived variables (DVs) can be used for complicated conditions that are used in several different places within the program and are likely to change. For example, on the LFS the questions on on work-based government schemes regularly change. They are widely used in the instrument. The current definitionand is currently defined as (YTETMP =1,2,4) OR (SCHEME = 5) OR (PROJWK = 2, 4). AIf a derived variable (DV) might usefully bewas computed for this set of conditions and then used throughout the instrumentprogram.; Wwhen the definition changes,d only the DV would require amendment. At present, if the definition changes, the routing to all individual questions which use that definition in their conditions requires amendment. Errors are therefore more likely to occur than if a DV is used. The fewer changes that need to be made, the less likely errors are to occur. It should be noted that good practice requires the name of the DV to be changed if its substantive content changes. If this is not done, there is a risk of introducing errors at the analysis stage. Analysts of the data may assume - reasonably but, in this case, incorrectly - that a variable with a single name has the same meaning throughout a longitudinal dataset. It is easy to add an incremental number to the DV name through the search and replace function.

5. Differences between developing new instruments and maintaining instruments for continuous surveys

This paper has concentrated on the amending and testing of instruments for continuous surveys. This accounts for a considerablemajor part of the work carried out within SSD/ONS. However, SSD/ONS also does manya number of one off *ad hoc* projects using CAI. The instruments for these surveys are completely new. They need to be designed and tested. As with continuous surveys, *ad hoc* surveys must be designed under stringentalso suffer from the budgetary and time constraints. However tThe major difference between instruements for *ad hoc* and continuous surveys is that testers cannot concentrate on particular parts oftesting changes to the instrument, as everything is new.

One way in which SSD/ONS has tried to address this problem is to use standardised blocks and templates. For example, there are standard blocks to ask questions on economic activity, and household composition. The author does not then have to worry about writing or testing these blocks and can concentrate on the survey specific blocks. The routing within these standard blocks has already been tested. When the testing

~~the~~ *ad hoc* instruments, the testers can test the routing to these blocks ~~is correct~~ in the same way as they would test unamended blocks on a continuous survey.

6. Conclusion

Producing error-free instruments is vital in producing good quality data. Practical survey work is done under stringent limits on time and resources, so it is impossible to test literally every combination of the variables and their categories. Fortunately, the strong structure-building features of Blaise and the possibilities for good design provide a basis for prioritising the testing.~~It is extremely difficult, if not impossible, to create a perfect Blaise instrument, particularly given the time and resources available to survey producers.~~ Nearly a decade of continuous and ad hoc survey work with Blaise in SSD/ONS has shown that data quality is much improved over paper questionnaires in the areas of instrument design that we attempt to improve through testing, such as routing. Testing aspires to be as scientific as possible, but the constraints under which it is done mean that there is value in the kinds of practical experience recorded in this paper.

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See also 'Blaise Testing Protocol' for a fuller list of all items that can be tested. Blaise Services at Westat, January 1997

Blaise III: Changing the data model after implementation

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1. Introduction

Recent development of statistical methods and techniques has opened many new possibilities in survey processing. Modern tools were developed to help statisticians and informaticians to get results - statistical information - in shorter time and with less effort. But, on the other hand, less and less time, money and human resources are available to get the same statistical information. Timeliness became a problem for many developers, and it usually results in lack of time to completely design and test the application. With CAI (particularly CAPI) applications this can lead to serious problems, when such an application is installed to many laptops, and some data are already collected and edited. Changing data definition means incompatibility of data files, which usually can not be solved without developers.
This paper describes one of the possible solutions for this problem, when the survey application is already in production. It can be used with the Blaise III applications. At the Statistical Office of Slovenia (SORS) it was successfully used with the continuos Household Budget Survey, conducted since February 1997, with the Pilot Census 1998 and some other surveys.

2. Slovenian Household Budget Survey - a short description

HBS in Slovenia has been carried out since 1963 on a larger sample (every five years about 3,200 households) and on a smaller sample (every year about 1,000 households). Since 1997 the Slovenian Statistical Office started with a continuos HBS. Every year about 1,200 (net) households shall be interviewed. Since this sample is too small for more detailed calculations, the data shall be aggregated together for 3 years. Every year the "oldest" 1,200 households shall be eliminated from the sample and the "newest" 1,200 households shall be included.
Becoming continuos, the survey was radically changed, with new survey and questionnaire design, new number of interviews, diaries were introduced and complete data processing was defined in a different way. A pilot survey (which was contemporary a Blaise III test survey at SORS) was conducted in October 1996. In February 1997 we started with the continuos HBS.
Compared with the annual Household Budget Survey, the continuos HBS was expected to have some advantages:

- Always current data of higher quality and lower costs
- Better organisation of the fieldwork and methodology of the survey because of the continuity
- Better trained and experienced interviewers
- More detailed results, derived from more subsequent years aggregated data

The main questionnaire is divided into two parts and interviewers visit each household twice. At the first visit, the first part is asked and the diaries (two types on paper forms, recording period 14 days) are explained. After two weeks the second part of the main questionnaire is entered and the completed diaries are collected.

3. The survey application design

From developer's point of view, the main problem with the Household Budget Survey was lack of time for application development. HBS is one of the most complex surveys: paper questionnaire consists of 72 pages and over 3,000 possible fields to be entered. The final version (February 1997) of the CAPI Blaise instrument consisted of 98 screens, mainly tables. But there were only about four weeks and one person available to develop the Blaise instrument, together with the entire case management.
Processing of the HBS main questionnaire data is completely independent from processing of diaries. The main questionnaire is processed in Blaise III as a multi-mode survey: there are 22 interviewers with laptops, using CAPI instrument and 4 data entrists, entering data from paper forms (PAPI/CADI). After coding of PAPI/CADI data (CAPI data are coded by interviewers), all data files are combined into one file and sent to SAS system for further processing.
CADI application for diary processing is still a Blaise 2.5 application. Coding is the most important part of it, so all three available types of coding are enabled: alphabetical, hierarchical and trigram.

If we wanted to follow the terms and to realise the education for interviewers, the application had to be installed to the laptops on the same day the last question was coded into Blaise language. So absolutely no time for testing was available. Furthermore, due to lack of time only the most important edits were included in the first production version of the Blaise instrument.
First small errors were discovered and removed already on the first day of interviewer's training. Since the second training day was a week later, time was used to improve and re-install the application and interviewer's interface. The interviewers were expected to start data collection and editing immediately after the second meeting, so that should be the final version.
But some more errors were found after the second installation, mainly not very important for data collection and editing (e.g. some unnecessary questions with an "empty" attribute were on the route). More important was the absence of some edits, which should be performed during the interview, but were not included in the first production version. Interviewers could start their job in time, but it was really necessary to improve the data entry and editing application.
After a month the HBS Blaise instrument was finally satisfactory and tested enough to prevent unexpected surprises. Some questions were removed from the route and many new edits were added. Of course, this changed data definition, and already collected data were not compatible with it.

4. Re-installing the survey application

When re-installing the HBS application we followed the instructions from the Blaise III Developer's Guide. Due to some difficulties in newly established modem communications between interviewers and the Statistical Office, we decided to send a new installation diskette to each interviewer, together with short printed instructions.
We were a little bit afraid of data conversion because of complexity of the questionnaire and especially because of additional interviewer's burden. Having this in mind, we prepared the re-installation procedure very carefully and made it as simple as possible, a real "push-one-button" solution. Interviewers were only asked to start the batch procedure, which installed some files and the new main interface menu, where they had to choose the new option called "Conversion to a new data definition". This option executed the following steps:

1. Creating the OLD directory and copying the existing data files into it
2. Installing the new improved survey application to a working directory
3. Installing and executing of Manipula conversion setup (from old to new data definition)

The Manipula setup to convert data from the old to the new data definition can be generated automatically any time during survey processing on the basis of metadata definitions, which are always present. Therefore, the conversion procedure can be executed more than just once, if necessary. Automatic linking of different data models is the key of the entire procedure: development of the conversion application would be much too time consuming.
When working, the interviewers use the new application exactly in the same way as the old one. A backup version of old data and metadata was automatically saved in a separate directory.

Conversion to the new data model in production was quite successful. Only with two interviewers problems occurred, mainly because they didn't exactly follow the instructions. Re-installation procedure was developed in a such way, that it was possible to repeat it without loosing the necessary files, so also these problems were solved relatively fast.
With the new data definition and new editing rules, some errors appeared also in previously clean records and the interviewers had to check all the records again. Since changes did not require another contact with already interviewed households, it was not too hard a job.
The same procedure was performed on the centralised part of the survey application, on PAPI/CADI data files at the Statistical Office. The old and the new data definition were the same as in CAPI instrument, and new data files from both modes of data collection were combined into one file again. New SAS setup was produced from the new data definition and data were sent to further processing.

5. New possibilities for application developers

A unified strategy for an improved editing process starts at the design phase and ends only when the final results are published. The desired final result is high quality statistical information. The aspects of quality of statistical information are accuracy, timeliness and costs[6]. It's not hard to conclude that the possibility of changing the survey design after implementation could improve especially timeliness, which usually affects also the other aspects. And which benefits we can get from using this possibility? We found some from our experience with the HBS:

- The survey data collection can start in time even if the data model is just roughly designed and tested
- The subject matter people can make last corrections in survey contents even after implementation (if really necessary)
- Interviewer's remarks can be considered and used in the final version of the application
- Edits can be added or removed during the survey data processing
- Development and production of the survey can run concurrently

There are some disadvantages, too:

- Additional interviewer's burden (even if small...)
- Adding new fields usually means repeated interview
- More survey administration

In case of our HBS the advantages were clearly prevailing, so this approach or a similar one will be probably used also in some other surveys at SORS, especially when rapid application development is necessary.

W.A.M. de Jong: Designing a Complete Edit Strategy; Combining techniques

The same approach was used with the 1998 Pilot Census. Like in the HBS, it was impossible to anticipate and define all the relevant edits before data entry had started. Since it was a CADI survey, data conversion between different models was relatively simple.

Both applications fully utilised the possibility of ASCII-relational reading blocks of data out of Blaise, which enable efficient loading of Oracle database and analysis of individual blocks of data. This is specially important with large data models. Concerning relations to other systems, this option seems to be one of the most important improvements in Blaise (of course, we are all looking forward to ODBC in Blaise 4 Windows).

5. Conclusion

Growing needs for faster and more accurate statistical information are often in conflict with developer's possibility to complete and test the survey application in time. With tools and methods, which enable completing and finalising the survey even after its implementation, some extra time could be acquired. In many cases only little extra time for development means the difference between interviewer's exhausting hard work and easy, user-friendly data collection and editing. The possibility of redefining the survey after implementation can improve timeliness as well as the quality of collected data.

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TADEQ: A Tool for Analysing and Documenting Electronic Questionnaires

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Introduction

National Statistical Institutes (NSIs), research institutes, and commercial marketing research organisations are increasingly using computer-assisted interview (CAI) systems for collecting survey data[i]. The paper questionnaire is replaced by a computer program that guides the respondent through the questionnaire and checks the answers on the spot. The growing possibilities of computer hardware and software have made it possible to develop very large and very complex electronic questionnaires. Unfortunately, it has become more and more difficult for developers, interviewers, supervisors, and managers to keep control of the content and structure of CAI instruments. Secondary analysts of the microdata - and even some of the analysts within the agencies collecting data by CAI - have found it difficult to use the questionnaire documentation, which looks completely different from the documentation they are used to (i.e. paper questionnaires). Sometimes, the CAI documentation is no more than the questionnaire program or a simple listing of the questions without routing information (so the user is forced back to the program). Some CAI software packages can produce a paper questionnaire version for simple surveys, but the social surveys typically carried out by NSIs and research institutes are much larger and more complex than these can cope with. Moreover, CAI instruments can include important information about the questions which paper questionnaires do not, such as edit checks and detailed interviewer instructions. This paper argues that CAI documentation ought to make all this information available, in a range of easily accessible options, for the different types of users with their varying needs.

With *4th Framework* funding from the European Commission, a research project has been set up under the leadership of Statistics Netherlands (see Section 5 below) to develop a tool for human-readable presentation of the electronic questionnaire. This tool is called TADEQ (Tool for the Analysis and Documentation of Electronic Questionnaires). The output of such a tool can serve to document (on paper, or electronically in hypertext form) an electronic questionnaire in a human-readable way. Such a tool should not only provide a useful documentation of the contents and structure, but also help to analyse the questionnaire, and report possible sources of problems in its structure.

This contribution contains a description of the TADEQ project. Section 2 gives some background with respect to the phenomenon of computer assisted interviewing. Section 3 explains the problem of documenting electronic questionnaires. Section 4 describes the possible analysis functions of the proposed tool.

2? Computer assisted interviewing

Our complex society experiences an increasing demand for statistical information. Such information enables policy makers and others to take informed decisions for a better future. Although administrative records in registers and other databases can sometimes provide the required information, more often they cannot. In this case, the sample survey is a powerful means to collect new information

Carrying out a survey is often a complex, costly and time-consuming process. The first step in the process is the survey design phase, in which the statistician specifies the population to be investigated, the data to be collected, and the characteristics to be estimated. Also a questionnaire has to be designed, containing the questions to be asked of the respondents. Furthermore, in the case of a sample survey, the sampling design must be specified, and the sample must be selected accordingly.

The second step in the process is data collection. Traditionally, in many surveys the questionnaires are completed in face-to-face interviews. The quality of the collected data tends to be good. However, since it typically requires a large number of interviewers, who may all have to do much travelling, it can be expensive and time-consuming. Therefore telephone interviewing is sometimes used as an alternative. However, there are limits. Telephone interviewing is not always feasible: only connected people can be contacted, and the questionnaire should not be too long or too complicated. A mail survey is cheaper still: no interviewers at all are needed. Questionnaires are mailed to potential respondents with the request to return the completed forms. Although reminders can be sent, the persuasive power of the interviewer is lacking, and therefore response tends to be lower in this type of survey, and so does the quality of collected data.

If the data are collected by means of paper forms, completed questionnaires have to undergo extensive treatment. In order to produce high quality statistics, it is vital to remove any errors. This step is called data editing. Routing, range and consistency errors have to be detected and corrected, but this can be very difficult if it has to be done afterwards, at the office. In many cases, particularly for household surveys, respondents cannot be contacted again, so other ways have to be found to do something about the problem. Sometimes it is possible to determine a reasonable approximation of a correct value by means of an imputation technique, but in other cases an incorrect value is replaced by the special code indicating the value is ‘missing’.

The computer has always played in important role in processing survey data. In the early days of the computer era, the computer was only used for sorting, tabulation, and checking. In the sixties, the computer was increasingly used for statistical analysis. The rapid development of information technology in recent decades made it possible to use microcomputers for computer-assisted interviewing (CAI). The paper questionnaire is replaced by a computer program containing the questions to be asked. The computer takes control of the interviewing process. It performs two important activities:

- *Route control.* The computer program determines which question is to be asked next and displays that question on the screen. Such a decision may depend on the answers to previous questions. Hence it relieves the interviewer of the task of taking care of the correct route through the questionnaire. As a result, it is not possible anymore to make route errors.

- *Error checking*. The computer program checks the answers to the questions which are entered. If an error is detected, the program gives a warning and one or more of the answers concerned can be modified. The program will not proceed to the next question until all detected errors have been corrected.

Application of computer-assisted data collection has three major advantages. In the first place it simplifies the work of interviewer (no more route control), in the second place it improves the quality of the collected data, and in the third place data is entered in the computer during the interview resulting in a clean record, so no more subsequent data entry and data editing is necessary.

The first mode of interviewing for which computers were used, was Computer Assisted Telephone Interviewing (CATI). This is a form of telephone interviewing in which the computer selects the proper question to be answered. This question is displayed on the computer screen, and thus can be asked by the interviewer. The answer is typed in and the computer checks it for range errors and consistency errors. If an error is detected, the computer warns the interviewer that something is wrong, and corrections can be made.

A more recent technique is Computer Assisted Personal Interviewing (CAPI). It is a form of face-to-face interviewing in which interviewers use a small laptop computer to ask the questions and to record the answers, instead of the traditional paper form. It is like CATI except that interviewers equipped with laptops visit respondents, usually at their home addresses. The laptops communicate with the central office by telephone, sending completed interviews and other data about the sample and receiving new CAPI instruments, new addresses, email and other electronic items.

Mail surveys are also becoming more and more automated. This form of computer assisted interviewing is called Computer Assisted Self Interviewing (CASI). In a CASI survey, the electronic questionnaire is sent to the respondents (on diskette, or by modem). The respondents run the interview program on their own computers, answer the questions, and the data is sent back in the same way it came.

CATI, CAPI and CASI are the main forms of CAI. New varieties are constantly under development, such as CASI via the Internet and audio-CASI[ii].

There are related forms of electronic data collection, such as Electronic Data Interchange (EDI) and passive observation methods such as linking supermarket bills with personal information on loyalty cards. This paper, like the project it describes, is confined to electronic data collection where the data to be collected do not already exist in accessible electronic form, i.e. where some form of interview or self-interview is required to obtain the information.

The growing possibilities of computer hardware and software have made it possible to develop very large and very complex electronic questionnaires. It is not uncommon for electronic questionnaires to have thousands of questions, although only a sub-set will apply to any particular respondent. Routing structures and filter questions see to it that respondents are only asked relevant questions for the particular sub-population to which they belong. Another aspect of

complexity concerns the structure of the instrument. Many survey questionnaires are of a hierarchical nature. A relatively simple but common example is a health survey, with questions at the household level, then at the level of each member of the household. Within each person there may be questions for each medical problem or each visit to the doctor.

Due to the increasing size and complexity of electronic questionnaires, it has become more and more difficult for developers, users and managers to keep control of their content and structure. Although several computer assisted interviewing systems have high level authoring languages to specify questionnaires, it takes a substantial amount of knowledge and experience to understand large and complex questionnaires. It has become more and more difficult to comprehend electronic questionnaires in their entirety, and to understand the process that leads to responses to each of the questions as they ultimately appear on data files.

This raises the question of the feasibility of a tool to represent the content and logic of an electronic questionnaire in a human-readable way. Such a tool should not only provide a useful documentation, but also help to analyse the questionnaire, and report possible sources of problems.

2? ? Documenting electronic questionnaires

When surveys were conducted with paper questionnaires, there was no need for separate documentation of questions and routing. Interviewers' instructions and edit checks carried out in the office were usually available in separate documents, though if these were computer programs they tended to be even less readable than CAI programs. Nevertheless, the paper questionnaire, developed for the interviewer's use, contained all the information available about the questions. Routing instructions were kept simple, in order to allow the interviewers to process the skip instructions themselves.

Computer assisted interviewing brought about two changes: the paper document was replaced by a computer program, and it became possible to implement more complex route logic. So, data collection instruments are more complex, and there is less documentation to understand them.

In the early days of computer assisted interviewing, when electronic questionnaires were developed for computers of limited memory size and speed, it was still possible to produce documentation by hand. There are ample examples of hand-made flow charts. The recent developments in information technology have made it possible to create such large and complex questionnaires that the cost of creating and maintaining documentation by hand has become prohibitive.

An additional problem of manual documentation is that it can be a source of errors. Whatever means are used to express the contents and logic of the questionnaire in a way accessible to a broad group of users, the information is conveyed in a form essentially different form the authoring language of the CAI system. Human translators only can perform their documentation task if they completely understand the electronic questionnaire specification. This is a subjective and error-prone task. Subtle errors are easily introduced. Moreover, it is difficult in practice to ensure that updates to the CAI program are carried over into the documentation, particularly as

these updates tend to be made under extreme time pressures. The errors from manual translation will usually go by unnoticed, causing the user of the documentation to form an erroneous picture.

Consistent and error-free documentation can only be obtained if it is generated automatically. All information about the content and structure is in essence available in the electronic questionnaire. What is needed is a software tool capable of automatically translating this questionnaire specification into a human-readable format.

4? ? A documentation tool

A documentation tool for electronic questionnaire should be able to produce human-readable documentation both in paper and electronic form. On the one hand, this tool must be able to make clear what the global structure of the questionnaire is, and on the other, it must provide means to focus on the details of parts of the questionnaire.

The global structure of the questionnaire can be represented by a routing graph. This is a graph in which each vertex represents a question, and each edge a possible transition to a next question. The challenge of the project is to display the routing graph of large and complex questionnaires. Due to the limited size of a sheet of paper and a computer screen, this is not a simple task. It must be accomplished without affecting the readability. It means a lot of attention has to be paid to layout issues.

The documentation of the questionnaire will be used by different kinds of people involved in the survey process. For many of them, the documentation will need to be in a more accessible form than even the highest level CAI language can provide. Examples of the different types of users include:

- The questionnaire developer, who wants accessible documentation for a variety or reasons, such as the important role it may play in independent testing that the CAI program meets the original specification (it may be cost-effective to employ for this testing staff who lack the skills to understand the CAI program). Proper documentation may also reduce the efforts to be spent on subsequent versions of the survey.

- The customers and managers who have to give formal approval for carrying out the survey. It is not surprising that customers and managers, while welcoming the cost-effectiveness of the transition to CAI, have often expressed their concern at the disappearance of the paper questionnaire. They perceive the paper questionnaire as a readily accessible means to understand what is going in the survey, and are dismayed by the absence of an acceptable substitute in CAI systems.

- The interviewers. It can be difficult for interviewers to get an overall picture of the interview and all its possible routes from running the CAI instrument. A paper document of the questionnaire can be of great help in the interviewer's preparation for fieldwork.

- The data analysts, who need a well-documented codebook if they are to work efficiently. Before CAI, the paper questionnaire was usually the starting point for producing such a codebook.

Different users may require different formats of the questionnaire documentation. Customers and senior managers may wish to concentrate on the questions asked, without getting lost in the detail of the edit checks and interviewers' instructions. Other users, such as secondary analysts working on the microdata, may need more detail. The same users may need more than one format: for example, interviewers may need a summary view of the main topics and their order in the interview and also a detailed listing of the questions. So, the proposed documentation tool must be flexible. The users of this tool must have some control on adjusting the documentation. Research must show what is required and by whom.

The documentation tool must not only display the routing graph, but also additional information. Since each vertex of the routing graph corresponds to a question, information about the question can be display closed to each vertex. Depending on the CAI system used, all kinds of question information can be displayed: the identification of the questions, the text of the question (possibly in different languages), the specification of the type of accepted answers, etc. The available amount of space in the graph is too limited to display all this information. Moreover it might affect readability. Therefore, a documentation tool must provide the means to select the information shown, and possibly also means to display information in different ways, e.g. adjacent to the graph.

The same problems apply to the routing information. It is important to display the conditions determining transitions from one question to another. Such conditions may be quite complex. Solutions have to be found to show this information without affecting readability and interpretability.

A questionnaire documentation tools must be able to generate output in at least two different formats:

- Paper documentation. This is static documentation. Once printed it is not possible any more to manipulate the information. The challenge of the paper format is that two, almost conflicting, goals must achieved. On the one hand, it must be able to show the global structure of the questionnaire in a simple way without being distracted by a wealth of detailed information. On the other, the user must be able to find detailed information about a specific question or route instruction.

- Electronic documentation. Although the small size of a computer screen causes even more limitations then a piece of paper, electronic documentation has the advantage that it can be dynamic. It provides possibilities like zooming in to specific parts of the questionnaire, clicking on vertices or edges to obtain more information, and using hypertext techniques to navigate through the documentation.

A tool for the automatic documentation of electronic questionnaires must obtain its information about the questionnaire from the CAI system used to design the questionnaire. There are several

general CAI systems in use in the world. Examples are Autoquest, Blaise and Cases. Each of these systems uses a different authoring language. Therefore, it is difficult to build a documentation tool capable of reading electronic questionnaire definitions of any CAI system. To solve this problem, a two-step procedure is proposed.

The first step is to design a neutral file format for the documentation tool. The file structure should be such that all information required for documenting the questionnaire is contained in the file. So, it must contain information about both the questions and the routing. The documentation tool will acquire its information from this type of file.

The second step is to create conversion tools for CAI systems. It depends on the structure of the questionnaire specification of the CAI system how complex this job is. Within the framework of this project it is proposed to develop a prototype of one such tool. It is the conversion tool for the Blaise system. The reasons for this choice are that there is extensive Blaise knowledge among the participants in this project, and moreover, the use of Blaise is widespread among the member states of the EU.

4? ? A diagnostic tool for analysing the CAI instrument

A tool like the one described in the previous section could have much more potential then just documenting a questionnaire. It could also play an important role as an instrument to measure the quality and performance of the questionnaire. As a diagnostic instrument, it could be used in the design process. The tool can provide information like

- The number of different possible routes through the questionnaire
- Longest route, shortest route, average route
- The conditions under which specific questions are answered

The last item in the list may provide particularly useful information. It helps to make clear whether questions are indeed answered by the intended respondents. It may also show errors in the questionnaire design, like routes that never will be followed, and questions that will never be answered.

There can also be a role for the documentation tool after the fieldwork has been completed. The tool's importance to data analysts has already been mentioned. One example of a new kind of way that the tool could help analysts to check their data quickly (as an improved way of examining frequencies) could be to compute how many respondents followed certain edges in the routings graphs. Such information can be represented in a numerical way, but also in a graphical way (e.g. by taking the width of the line in the graph proportional to the number of trespassers).

In view of the interesting possibilities, it is proposed to extend the documentation tool with diagnostic functions for analysing the CAI instrument. Hence, it becomes a Tool for Analysis and Documentation of Electronic Questionnaires. The acronym TADEQ will be used for this tool.

5. The project

The TADEQ project is being carried out by a consortium consisting of five partners. The main contractor is Statistics Netherlands. The second partner is the Max Planck Institute in Saarbrücken in Germany. It will be responsible for providing the necessary mathematical knowledge and experience in handling, analysing, and displaying graph-like structures. It is expected to deliver software modules required for graphically displaying the routing structure of an electronic questionnaire. The third partner is the Office for National Statistics in the United Kingdom. This national statistical institute is long time user of CAI techniques. With the help of Statistics Netherlands, it has produced a Blaise Automatic Documentation tool which goes part of the way to answer users' needs; however, much remains to be done. Also, ONS has many contacts with CAI users in Europe and elsewhere in the world. It will be responsible for surveying and defining user requirements, and will co-ordinate evaluation and testing of prototypes. The fourth partner is Statistics Finland. This national statistical institute has substantial experience with CAI techniques, and the development of CAI management systems. Statistics Finland will contribute user requirements and test prototypes. The fifth partner is Instituto Nacional de Estatística in Portugal. This national statistical institute has experience in using CAI for major surveys. It also participates in other European projects in the field of automated data collection (EDI).

To create the TADEQ, a stepwise approach has been implemented:

1? Evaluation of user's experiences and wishes with respect to documentation of electronic questionnaire. This means consultation with several users of CAI systems in Europe.

2? ? Development of the TADEQ neutral file format. A number of major CAI packages will be evaluated in order to make an inventory of what they produce with respect to question and route information.

3? Development of a module capable of producing paper documentation. Initial exploration has shown that this function has priority. A key requirement of Blaise users, particularly the large corporate licence holders, has been for rapid development of a means for producing paper documentation automatically. Early development of a prototype within the TADEQ project will be an efficient means to meet this need and avoid the requirement for a separate project to provide a short-term solution.

1? Development of a module capable of producing electronic documentation.

2? Incorporating analysis functions.

It is important that users of the CAI are involved in the development process. At some points a selection of users will be offered prototypes for evaluation purposes. Their comments and remarks will be taken care of in the subsequent phases of the development process. The project aims for a prototype to be available for testing by the end of the millennium.

Section D. Case-studies of Blaise surveys

Redesign Labour Force Survey: Statistics Netherlands 1998

Marien Lina, Statistics Netherlands

Methodological design

Sampling methodology: Kees van Berkel
Questionnaire design: Wieneke Groot

Technical design

Blaise implementation: Marien Lina
Panel system/Maniplus: Henk Fuchs

Credits

Cornelis van Bochove, Annemarie Boelen, Piet Boersma, Jo Bogman, The Blaise Development Team, Tom Boves, Paul Bracke, Frans Brouns, The GEP Help Desk, Bert Geurts, Anja van de Graaf, The Interviewer teams, Catrien Jacobi, Frans Kerssemakers, Cor Kragt, Isje Kuijpers, Jo van de Laarschot, Lydia Leers, Ron Lemmens, Annemiek Luijten, Mirjam Janssen, Ren, Nijman, Arno Plucinski, Jo Ploum, Piet Prak, Marielle Reemers, Wilfred Riksen, Jos Schiepers, Hub Schings, Ger Sleijpen, Edith Schobben, Jo Thomas, Jaques Thijssen, Johan van der Valk, Heleen Voogdt, Mariette Vosmer and Willem Wetzels

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Introduction

The Enquête Beroeps-Bevolking (EBB) is the Dutch labour force survey (LFS) of households living at private addresses in the Netherlands. It is carried out by Statistics Netherlands on behalf of Dutch governmental institutions (Centraal Planbureau, Ministerie van Sociale Zaken en Welzijn, Ministerie van Economische Zaken, Ministerie Onderwijs Cultuur en Wetenschappen). Statistics Netherlands is also responsable for delivering statistical data about labour force and unemployment to Eurostat.

Until 1985, the Dutch labour force survey was called the Arbeids Krachten Telling (AKT). It was a paper and pencil survey which was carried out every two years in about 160.000 households. While Statistics Netherlands organised the AKT, the field work was carried out (or delegated) by Dutch municipalitites. With the introduction of the EBB, Statistics Netherlands took over the field work. In 1987 the first computer assisted version of the EBB (using the Quest package) replaced AKT. In 1992 the Blaise version of the EBB replaced the Quest-version.

The Enquete Beroeps Bevolking is the first computer assisted survey at Statistics Netherlands. Since its introduction, each year Statistics Netherlands adresses 140.000 private households to participate in the labour force survey. They are visited by one of the (approximately 650) field interviewers of Statistics Netherlands. A part of the responding households are requested to participate in the subsequent waves. If they agree they will be addressed by phone three times for a short Cati interview.

After this short history about the EBB and the AKT, below the term labour force survey will be used to refer to the Enquete Beroeps Bevolking.

Technical reasons for a conversion.

There were two main reasons to adapt the labour force survey thoroughly. Firstly, technical developments (the development of Blaise III) asks for more than a one-to-one conversion. Blaise III offers more sophisticated development options, enabling a larger and more complex survey design. Secondly, the need for more information asked to combine the conversion with a complete redesign.

This second reason explains why Statistics Netherlands has waited some time to convert the labour force survey from Blaise 2.5 to Blaise III. The labour force survey-version in Blaise 2.5 is still active for data collection. Currently, the revised field edition in Blaise III has been converted successfully. At this moment this version is tested in a field experiment.

However, there may have been some resistance to switch to Blaise III. Interviewers are used to the old version. To a large extent, the Blaise 2.5 version of the labour force survey does what it is supposed to do, and to some extend it was feared that the creation of a new measurement instrument could have caused bias in the unemployment figures. These and other problems still cause a delay in the implementation of the new version of the labour force survey as soon as possible. However, the technical reasons for the conversion have become more and more urgent. Blaise 2.5 does not meet the requirements of the current network under Windows NT at Statistics Netherlands.

The conversion means a complete system change. The CAPI-interview had to be made suitable for Blaise III. A first one-to-one conversion proved to result in an unworkable version. To face this problem, a technical redesign was necessary. As Blaise III enables to call a block (or field) on different places in the route, similar blocks in the Blaise 2.5 version could be reduced to one block (or field). The old version contained much of these similar blocks. Using a modular approach the model of the revised labour force survey became much more transparant.

The purpose of such a conversion is not restricted to take advantage of the technical features of Blaise III. The policy of Statistics Netherlands is directed towards a situation in which all surveys are integrated in one system. This policy asks for the conversion of the labour force survey. As the extensive POLS (Life Situation Survey) interview is readily available as a Blaise III interview, the same is desirable for the labour force survey. Using the same Blaise version for all surveys at Statistics Netherlands facilitates the organisation of the statistical production process.

The wish to integrate the surveys is not restricted to the Blaise version for the Capi and Cati interview application. All surrounding systems are part of the statistical process. When it comes to data communication procedures, panel management, mixed-mode management, Capi- and Cati-administrations, payment administration for interviewers and coding procedures, the mentioned policy asks identical systems for all surveys at Statistics Netherlands. Also, hardware and system requirements for laptops in the field should be uniform for all surveys.

When it became clear that the Blaise III conversion implied more than a simple conversion this made statisticians start to think of a complete new survey design.

Why a new survey design

The reasons for a new survey design are not surprising. The information requests on developments in employment and unemployment are rapidly increasing. The main users of statistics in this field in the Netherlands (Centraal Planbureau and Ministerie van Sociale Zaken en Welzijn) and the European Statistical office Eurostat require labour and unemployment figures each quarter of the year. This does not only imply the addition of new topics and questions in the interview, but also an increase in the number of desired responses.

Changing the number of CAPI and CATI interviews within the acceptable level of expenses made it possible to increase reliability and precision of data by changing the population size and the number of waves.

While on the one hand there is a wish to extend the survey with relevant new sources of information, on the other hand the economical principle asks to avoid gathering redundant and unused data. In practice, over the years, a survey tends to grow larger and larger. Each small revision may lead to an increase of gathered information. It is seldom heard that the statistical department asks to stop gathering certain information. In the redesign project, an evaluation has been organised to check whether it may be better to stop asking certain redundant questions and to put an end to gathering useless and unused information.

The conclusion is the conversion and redesign served more than one purpose. Technical reasons, uniformity of applications, the need for more information and the need to keep it simple and avoid useless data gathering are some of the ingredients for the discussions about the revision at Statistics Netherlands.

The project team consists of engineers from various departments and different disciplines. Different objectives between disciplines and departments means a risk. While running the project, the main objective was to keep the overall aim of the project in mind.

Wishing a larger population

The redesign did not only affect the content of the questionnaire. Also the sampling method has been reconsidered. As well Eurostat as Dutch user's of labour statistics asked for higher levels of reliability.

The sample population of the Labour Force Survey in the Netherlands is a random part of its inhabitors aged 16 years or older. For sub-populations consisting of about 5% of the entire sample, Eurostat wishes to keep the relative standard error of the estimator of the mean value in a year on Nuts-II level below 8%. The precision still has to be better for statistical figures on the national level. The relative standard error of the estimator of the difference of two successive quarterly figures on national level may not be more than 3% (1.5% for countries with a population larger than 20 million).

The *Centraal Planbureau* and the *Ministerie van Sociale Zaken en Welzijn* ask for a certain degree of precision and reliablility. Firstly, this concerns the part of the population that belong to the employed or unemployed labour force. At a given level of reliability, yearly figures in the new version may not be less precise than they are in the Blaise 2.5 version of the survey. Continuation of the current levels of reliability and precision are desired. Secondly, The difference in two successive quarterly figures must have the same level of reliability and precision as the current difference in two successive yearly figures.

As well for Eurostat as for the Dutch users of data from the labour force survey, higher levels of precision and reliability are desirable. To reach these higher levels, a larger number of observations is required. To reach this not the sample size will be enlarged, but the number of subsequent waves will increase in the new version.

The old panel system

Using the method of the labour force survey in the Blaise 2.5 version, the sample size should be increased 400%. Multiplying the number of field interviewers by four would be the simple solution, however this can not be realised within the available budget. The solution is a new approach, using rotating panels. The following table shows the way a survey panel in the Blaise 2.5 version is addressed for the labour force survey in four subsequent waves.

In the current approach, the time between two subsequent waves is 3, 3 and 6 months.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan’
Wave 1	A	B	C	D	E	F	G	H	I	J	K	L	A’
Wave 2				A	B	C	D	E	F	G	H	I	J
Wave 3							A	B	C	D	E	F	G
Wave 4													A

There are approximately 140.000 households involved in the first wave. They are visited on private addresses by an interviewer with a laptop. The basic Capi-interview is carried out and the persons are asked if they are willing to participate in the subsequent Cati-waves. Three months later, a limited part of the households are involved in the second wave. The responding households in the second wave will also be contacted in the third wave. This procedure is repeated until the fourth wave.

Sample and Rotating panel

The idea was to use a rotation scheme to enlarge the mass of the sampled population, enlarging the number of addressed households in the subsequent Cati-waves. The sample size of the first wave should not be increased. For the new design, various wave schemes have been considered, among which the English and the Italian system.

Considered Wave Schemes for the Labour Force Survey.

Country	N of Waves							
		Quarters						
		K	K+1	K+2	K+3	K+4	K+5	K+6
English (GB)	5	?	?	?	?	?		
Italian (I)	4	?	?	-	-	?	?	
Dutch (NL)	4	?	?	?	-	?		
English-plus (GB+)	6	?	?	?	?	?	?	
Italian-plus (I+)	6	?	?	?	-	?	?	?
Dutch-plus (NL+)	5	?	?	?	-	?	?	

Most of the wave schemes show one or more periods in which no field work is carried out. At first sight, the English system in which over a period of one year the panel is addressed every quarter of a year appears to be the simplest and most practical scheme, not only for the analysis, but also for the organisation of panel management.

Sample and Rotating panel

The revised labour force survey in the Netherlands will use the first scheme: 5 quarterly waves for the entire sample population. Each month the current situation of an approximately constant proportion of the Dutch population can be compared with the situation of the same proportion three months before.

In global terms this results in a situation where:

? There is a minimum number of waves that meets reliability demands

? There is a maximum number of cases in first wave

? It is an elegant and user-friendly method

A note about two sources for trend figures

In 1998 and 1999 the second, third and fourth wave will not been carried out. The wave-system enables to follow the factual situation of persons over some time. Within the labour force survey, also a retrospective part (the Retro) is present which asks about previous jobs. In fact these are two methods with the same objective: to measure individual changes.

Despite the fact that a measurement on a certain moment (during the follow-up waves) would be more precise, this retrospective supplies information of the job situation of a longer period. Organisational problems made it necessary to skip the Cati-waves for 1998 and 1999.

In the Blaise III design of the labour force survey, the intention was to discard the retro. However, the intended wave schemes have not yet been implemented. Before the wave scheme is implemented, the Retro will stay active in the labour force survey. The current idea is to omit the Retro as soon as the panel system has been proven to be successful.

The organisation of the changed Capi interview

The basic interview (the first wave) is a Capi interface during a household visit. For the field interviewers and the organisation of the field work the procedures will not change radically. Yearly, changes and preparations of the questionnaire are followed by interviewer instructions and training. For the new survey, another type of datacom will be used by the interviewer. The interviewers already know this kind of datacom-interface from the POLS-survey.

Like the old labour force survey, each month a sample will be installed on the field-laptops by datacom and the administration of the year-sample will be up-dated. The interviewers receive announcement letters by mail. They forward them to the addresses printed in these letters. After announcing the interview in this way, the interviewer visits these addresses. All the organisational aspects for the field interviewers are the same as in the Blaise 2.5 version.

One household interview takes usually about 28 minutes. Also here there is no change in comparison with the previous version, which lasted about 25 minutes. If the Retro will be descarded in the future, the amount of time may be decreased to less than 20 minutes. The mean household size is about 2 persons. Within each household up to 8 individuals may be interviewed. In the previous version the maximum number of persons to be interviewed was 4. Known that the percentage of households larger than 4 persons is quite low, this will not drastically modify the mean interview time. At the end of the interview the respondent will be asked to participate in subsequent waves (CATI). If nobody answered the doorbell, or for any other reason a non-response is scored, the interviewer fills out an electronical visit report. After returning home the interviewer mails the data from the laptop to Statistics Netherlands by standard datacom-procedures.

If the interview period of one month is expired the received data, after adding codes for example for educations and economic activities, the Division Data Collection transfers data to the Statistical analists. Non-response figures and field reports are prepared. After that the Cati-system for subsequent waves can be prepared.

An important condition

When producing statistics, the most horrible nightmare is an unexpected disturbance in statistical trends. This is what may happen when a new measurement instrument is developed. This formalised the basic condition for the new version of labour force survey version: The main routing of the questions and the contents of the literal questions should not be changed unnecessarily. This principle has been used as starting point in the discussions of all sub-projects in which separate blocks from the old version were analysed before designing the new modules.

Modular approach CAPI interview

Different topics of the interview have been developed in separate modules. All modules were developed in Blaise III from scratch. In the first wave the following modules have been implemented:

Household box

Ethnical background

Proxi

Labour field

Position at work

Status of labour-contract (structural / temporarily)

Hours per week

Free days per year (holidays / days of)

Illness

Overtime work

Working-hours

Traffic home-work-home

Private enterprise

Occupation / Profession

Labour conditions

Seeking employment

Retro (Previous jobs)

Education

Retirement / pension

Employment bureau

Membership trade union

Free time / leisure activities

Volunteer jobs

Social position

Mobility

Willingness to participate in the next waves

Most of these blocks also appeared in the previous version of the labour force survey. Nevertheless there were some changes.

Changes in the Capi-Interview:

Compared to the Blaise 2.5 version, the main changes in the Capi interview are the following:

? Module social position has been changed and now is one of the last blocks in the interview.

? Module labour searching has been added

? Module about working-hours has been changed

? The module about unemployment benefits has been omitted. The future possibility of using secondary data from unemployment registrations made it possible to decide this.

? As already mentioned before: the maximum number of individuals in the household that were involved in the Blaise 2.5 version was 4. Now this maximum number is 8.

Changes in the subsequent waves:

Compared to the old version the quality of feed back from the first wave is enhanced. In the new version, information about more than one job will be passed from wave to wave. In the old version only the name of the first job was passed from wave to wave. This kind of information transfer has been increased in the new version.

Another change is that the mean duration of the Cati interview has been reduced to approx. 6 minutes. The number of included modules in the Cati-interview is less than in the old version.

Within the modules of the Cati-interview, alternative routes have been used which are shorter than in the Capi interview. The modules are the same as in the Capi-interview. This route is controlled by import parameters. An overview of the used modules in the Cati version:

Modular approach CAPI interview

Household box

Proxi

Labour / fields of activity

Position at work

Labour-contract (structural / temporarily / other)

Hours per week

Private enterprise

Occupation / Profession

Seeking employment

Education

What not has been changed is the drop out handling. If a household does not respond in one of the waves, it will be discarded from the population in the subsequent waves. Hence, temporary drop out in just one wave is impossible.

Blaise III 'Conversion'

The Blaise III conversion was not a real conversion, but merely the development of a new complex questionnaire. Schemes were developed from scratch. These schemes formed the starting point for the development of the new Blaise interview. Each module has been developed as an independent unit. All information between modules is passed using import and export modules. Each module could be tested independently.

Panel management and integration of interview administrations.

At this moment still a crucial bridge lies ahead: completing the system for panel management and interview administration. In this system, the extensive Pols interview and the labour force survey will be joined with all other surveys that (structurally) take place in the division of data collection at Statistics Netherlands. The impact of this part of the project was underestimated in the planning. This may result in a delay for the moment the new version will be in the field.

Measuring the instrument effects

While the labour force survey has been developed from scratch, still many parts are identical to the previous version. Nevertheless the new version is a new measurement instrument. Despite the aim to measure the same, the structural responses in the new version may unwillingly deviate from the old version. This is why the old and new version will be together in the field for at least half a year. According to the current planning this parallel interviewing will take place from March until December 1999.

Blaise for Windows

At Statistic Netherlands, Windows has been installed on every site. Also the new laptops will run under Windows. MS-DOS-applications appear not to run as they should on the available platforms. This is why it is a general policy at Statistics Netherlands to make DOS-applications disappear.

The Blaise III version has been developed in Blaise III in the MS-Dos environment. Despite the fact that some typical layout differences between MS-DOS and Window layout characteristics ask for some adaptations of the questionnaires, this version runs immediately in Blaise 4W and the Windows version apperas to be stable enough for production.

It may well be possible that no Blaise III version of the labour force survey will ever be in the field for production, and that the switch will be made directly from Blaise 2.5 to Blaise 4W.

The 1997 Census of Agriculture Experience at NASS

Roger Schou and Asa Manning, National Agricultural Statistics Service (USA)

Introduction

The Census of Agriculture is conducted every five years for the years ending in two or seven. So in the decade of the 90's, the Census years would be for 1992 and 1997. Through the1992 Census, the Bureau of Census of the Department of Commerce was responsible for every survey. However, as the budget for Commerce was reduced during the mid-90's, funding for the Census of Agriculture was eliminated. This left the 1997 Census in jeopardy, but opened the door for the United States Department of Agriculture and specifically, the National Agricultural Statistics Service (NASS) to step in. Since NASS is responsible for every other federal government survey related to agriculture, the agency has always hoped someday to be able to "complete" its mission and assume responsibility for the Census of Agriculture. NASS approached congress about the Census being transferred to NASS. This was officially done prior to the 1997 Census of Agriculture.

Although NASS had a goal in its mission statement to assume responsibility for the Census of Agriculture in the future, the timing of the transfer presented a daunting task. Not only did the transfer happen quickly, but the 1997 Census of Agriculture was right around the corner. Planning for taking over the Census began during 1996. At that time, the mailing of the Census questionnaires was less than 18 months away. Not only was the timing tight, but the scope of the job ahead dwarfed any survey NASS had ever done. The Census of Agriculture attempts to collect data on every farm in the United States. A sample of 50,000 would be large by typical NASS standards, so attempting to gain a response from slightly less than two million farms in the U.S. was certainly a challenging task.

The Bureau of Census is essentially a centralized agency. Except for a large mailing facility in Jeffersonville, Indiana and CATI calling centers in Arizona, Maryland, and Indiana, all the staff assigned to the Agricultural Division, work in Suitland, Maryland, a suburb of Washington, D.C. In the past, almost all the staff assigned to work on the Census was located in either Suitland or Jeffersonville. When the responsibility for the Census was transferred to NASS, all staff in that division were given the option to transfer to NASS as well. A majority of the staff did transfer. That staff played a major role in educating the staff in NASS about conducting a Census of Agriculture survey, and served as the coordinators for the Census effort.

NASS is much more distributed with over half of our staff located in 45 field offices located around the country. As NASS planned for the Census, it wanted to take advantage of the local agricultural expertise of our field offices, but also had to tap the talents and experience of the staff from the Bureau, who had been involved in the prior Censuses.

Large Samples and Limited Time Frames

Another limiting factor was the tight time frame. The planning for the 1997 Census of Agriculture had been under way for about three years before NASS got involved. With such a short time frame available before the start of the Census, NASS was limited in what could be changed.

The Bureau of Census maintains a large facility in Jeffersonville, Indiana for handling very large volumes of questionnaires. NASS has nothing to compare to that infrastructure and it was decided that NASS would contract the big "paper shuffling" tasks back to the Bureau of Census. This would include questionnaire mailing, receiving and checking in the returned questionnaires, and capturing the data from those questionnaires.

The following random facts will help illustrate just how "much paper" was handled by the Jeffersonville facility for the 1997 Census of Agriculture.

First mailing	3.2 million questionnaires
Second mailing	1.3 million questionnaires
Third mailing	0.8 million questionnaires
Returns	2.7 million questionnaires (86.0 %)
Peak number of Jeffersonville staff	292
Peak number of data entry staff	126
Avg. questionnaires keyed/week	88,000
Total pieces of printed material	15.2 million

NASS decided to move certain data collection functions to the field offices. All follow-up for operations that did not respond by mail would be handled there. Some contacts were handled in person. However, a significant amount of data was collected by Blaise CATI. Whereas CATI was handled in the Bureau calling centers in 1992, when we looked at our options for 1997, the potential offered by our field offices in combination with the Blaise software were seen as definite strengths.

Once the decision was made to conduct the CATI work for the Census in the field offices, it was imperative that the local area network hardware be upgraded. NASS purchased two new Dell file servers for each field office. Additional Pentium workstations were purchased in order to assure that the low end workstation for CATI was at least a 486-33. In reality, for evening calling most interviewers would have Pentium workstations available.

The processes that followed editing, from analysis to publication were largely handled in the field offices, where the local expertise was most valuable. After all, these offices have a knowledge of the agriculture in their state that could never be equaled by the staff in HQ. Even here, the Bureau's computer systems in place for analysis and publication were used by NASS. Developing new systems was out of the question, due to time constraints. Essentially, the NASS staff was trained to work with the centralized Bureau processing systems. The NASS wide area

network was used to provide critical communication links between the Bureau computers and the field offices.

The following table provides some details on the Blaise CATI applications, planned and/or developed, that were part of the NASS effort on the 1997 Census of Agriculture.

Blaise CATI Applications
Developed by NASS for 1997 Census of Agriculture

Name	Expected time frame as of 6/98 frame	Actual time	Specifications Set	Instrument Used	Completed CATI Interviews
Screener		10/97-12/97	10/97	screener	238,000
Advanced Follow-Up		2/98-5/98	2/98	main census	56,000
Large Farm Follow-Up	3/98-6/98	3/98-6/98	2/98	main census	20,000
Not on Mail List (NML)	3/98-4/98	3/98-4/98	2/98	main census	1,000
Low Response County	4/98-6/98	canceled			
Last Call Follow-Up		4/98-5/98	4/98	main census	51,000
Classification Error Survey	4/98-9/98	4/98-9/98	2/98	CES	20,000
Non-Response Survey	4/98-10/98	4/98-7/98	2/98	NRS	20,000

In the column labeled "Expected time frame," there are no dates listed for the Screener, Advanced Follow-Up, or Last Call Follow-Up. This reflects that these applications were "birthed" as the process took shape. Lead times here were minimal. In some cases, an application would be needed in the field offices within a few weeks of learning that there would be such an application. NASS also was determined to conduct this Census in a shorter time frame than had ever been done before, and it was common for the schedule for applications to be accelerated. Fortunately, by structuring the applications in a modular fashion and enforcing certain standards across all Census CATI applications, we were able to react quickly to the challenges posed by the fluid nature of the specifications.

The ever accelerating schedule also created an environment where minimal training was possible. In fact, the only opportunity that we had to present our plans to field office staff in person was a one hour session in September 1997. If you glance at the above table, you can clearly see that specifications were far from firm at that point and two applications had not even been thought of yet. All we could provide at that time was a rough overview of how we thought things would unfold. We supplemented that training later on with a two-hour teleconference. Again, that training was very limited. The only other way we had to pass information to the field offices was a written document that accompanied each application when it was delivered to the field offices. Yet, despite this limited training that the field offices received, most of them coped very well with the Census CATI applications. We give credit to the intuitive nature of the user interfaces of the Blaise system itself, the rigid adherence to NASS standards where possible, and the sophisticated utilities which allowed us to build "user friendly" interfaces for interviewers and statisticians.

Using Coding Results to Influence Routing

The challenges presented to the Blaise developers were also technical. Four of the applications used the instrument for the main Census questionnaire, which was 11 pages long. The interviews could take up to an hour. The most challenging aspect of the instrument was that it had to be able to handle any of almost 300 crops. Trigram coding was used to build a list of the crops grown on the operation. Since there is a shorter list of possible livestock commodities, we used a more traditional method to build that list. The interviewer would then review the profile of the operation and if needed, refine the profile. Once the profile was set, the detailed acreage, production, and sales questions were asked for each crop, and inventory and sales questions for each livestock commodity.

Our usage of Blaise coding programs had been very limited. Using them during the CATI interview would clearly be a totally new experience for our interviewers. Our interviewers embraced this new technique more enthusiastically than we had ever anticipated. We expect that this approach will find its way into other NASS applications in the future.

Conducting the Agricultural Census in the United States required some clever programming to insure robustness within the Blaise instrument as well as the system that supported the application. From the standpoint of maintenance and support, having one instrument for the main Census questionnaire for all states was the only feasible alternative. At first glance, this may not seem to be much of a challenge. But looking more closely, one soon realizes the diverseness of the data to be collected across such a large population. As mentioned earlier, one scope of the Agricultural Census was to collect data on all crops grown in the United States. Each state had a specific list of crops that would typically be grown there, but very few states had the same list. Each state's list would be a subset of 294 unique crops which were identified prior to the survey. To avoid asking embarrassing questions like pineapple crops in Alaska, and to keep the interview length as short as possible, the instrument was designed to first poll the respondent of the crops that they had raised. Once this list was prepared, more detailed acreage and production questions for each of these identified crops were routed.

The trigram method of lookup was used on an external file that contained 296 records: the 294 unique crops, one "unknown" category, and one "done" indicator. In addition to the crop's name, abbreviation, code, and description, the external file included such data as the item code, crop category, whether the acreage was collected in whole numbers or tenths, the conversion to bushels factor, the unit of production, and the point value based on the value of production of the commodity. Therefore, once the list was built for the crops grown by a respondent, the instrument had everything it needed for the identified crops. The crop description and the crop abbreviation were defined as the trigram key.

The instrument was designed to hold up to 159 crops in nine categories. Each of these crop categories was defined as a table, and as the respondent identified the crops they produced, parts of the rows of the corresponding table were being computed from the data in the external file. Also, as a particular crop category was identified, LOCALS were being computed that would be used to determine whether each table would need to be routed, and other LOCALS were being incremented, keeping track of how many crops in each category had been reported.

Upon collecting the list of crops from the respondent, the appropriate tables were routed based on the LOCAL, and the acreage and production data for those crops were collected. The tables were processed from one up to the number of crops within that category. This helped keep the respondent on track, as data for crops within the same category were collected together, even though they may not have been reported by category.

Dynamically Creating Blaise Records with Maniplus and Manipula

Another technical challenge was presented by NASS's first experience with toll-free telephone numbers. Every Census questionnaire, including the Screener, gave the respondent a toll-free number that they could call with any questions. Staff in the field offices were trained to handle the inquiries posed by the incoming callers. On the screener application, since the interview was very short, it was decided to attempt to complete the interview once we had them on the phone. We had never dealt with "incoming" calls before and it took some effort to work this out.

Each state office conducted their own CATI portion of the Screener, whose main objective was to determine whether the selected unit was a potential farm, a non-farm, a duplicate, or an undeliverable address. The records with a Screener Outcome of potential farm, would later receive an Agricultural Census questionnaire. The Blaise instrument, developed to collect this data, used a series of screening questions to determine the outcome. In addition to the CATI samples, approximately 240,000 screener postcards were mailed, which included the toll-free telephone number. At the start of the survey, all of the toll-free calls came to our North Carolina field office. The mailed portion of the survey was treated as a separate application, although the same Blaise instrument was used to collect the data. The postcards that were returned by the respondent were scanned in at our North Carolina office, if there were no changes to the name and address.

The survey design had to allow for the cases of the mailed portion to be collected over the phone via the toll-free number, as well as entering the name and address changes. However, initializing all 240,000 cases into a Blaise data set would have been tremendous overkill, as only the forms with name and address changes and the call-ins would actually need a Blaise record. The case would also need to be retrieved in a timely fashion, so the respondent would not be lost. Using Maniplus, Manipula, and a Pascal tool, a system was designed that would dynamically build a Blaise record. The following describes the steps of the Maniplus setup.

First, the user was prompted for the identification number of the form to be retrieved or created. Second, the SEARCH method was used on the Blaise data set to see if the form already existed. If the form was not found, then the appropriate state ASCII file was searched using GREP, which is a Pascal tool that quickly searches the contents of a file for a particular string. The names and addresses of the 240,000 cases were split up by state, into multiple ASCII files with the corresponding state's number as the extension. This enabled the GREP search to find the record very quickly. The two-lined result of the GREP search was stored in a file. The first line was the name of the file that was searched, and the second line was the entire line that contained the id. Third, a Manipula setup was called that would update the Blaise data set with a new record containing the id, name, and address information from the GREP-created ASCII file. In order to process only the second line of this file, the computations and WRITE statement were enclosed in an IF-ENDIF construct using the RECORDNUMBER method.

The remaining steps of the Maniplus setup were the same, whether the Blaise form was newly created, or already existed. The GET method was used to retrieve the form from the data set. A dialog box (Figure 1) was then opened displaying the id and name fields and a check box used to obtain the Screener Outcome without invoking the Data Entry Program (DEP) and answering the series of screening questions. Four buttons were available in this dialog including one to accept the outcome entered, one to retrieve the form in the DEP, one to invoke a name and address update dialog (Figure 2), and one to cancel.

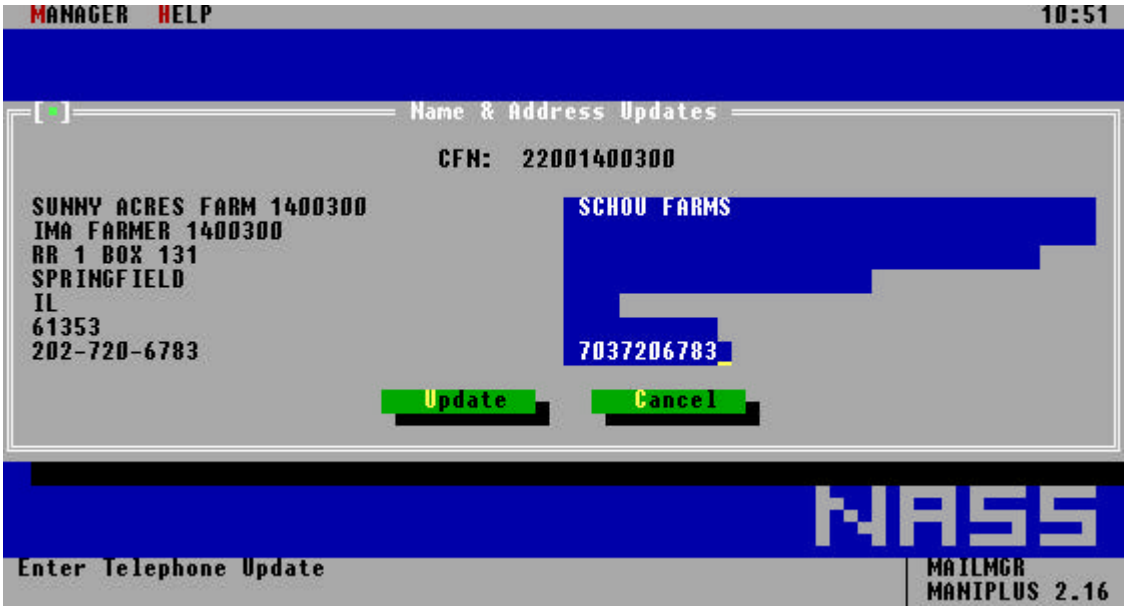


Figure 1 Name and address update dialog box

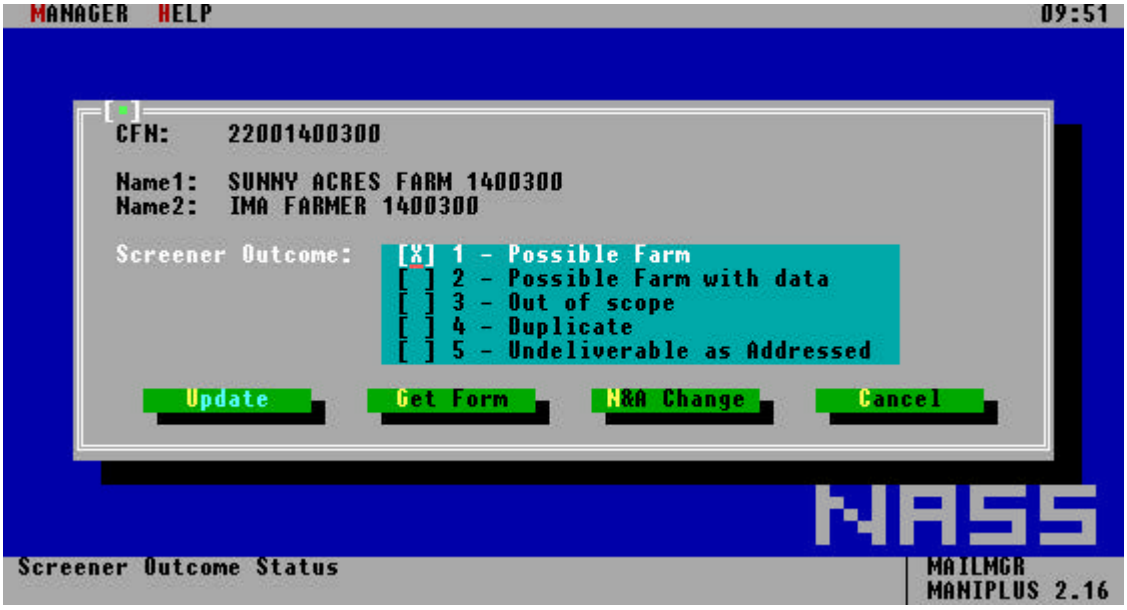


Figure 2 Screener outcome dialog box

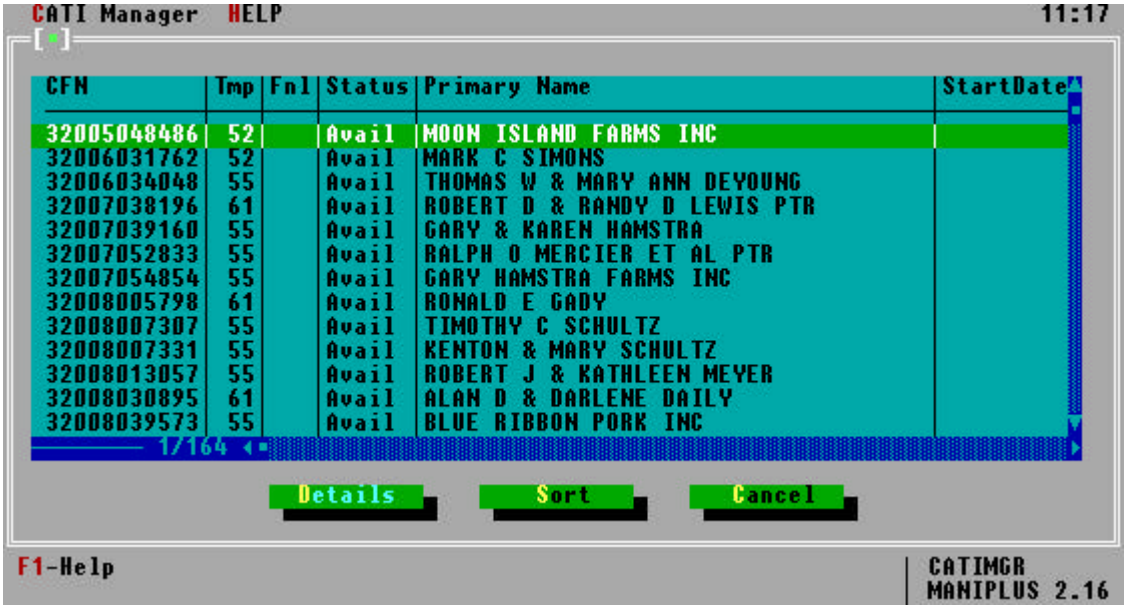
Using Maniplus as a Management Tool

All the Blaise applications used a couple of "outcome codes" to track cases through the system. A Final Outcome Code (FOC) was assigned when a case was resolved and ready for output. The Temporary Outcome Code (TOC) would be assigned if the case needed some type of special handling. This usually meant that the case could not be resolved by the normal CATI process. The "main Census" instrument was programmed to set these codes based on the results of a CATI call. A more challenging issue was building a user interface to offer the end users an efficient way to manage those cases with a TOC. We took advantage of one of the more powerful abilities of Maniplus, which was the ability to update certain key fields in the Blaise data set without starting the interview instrument. We had never done anything similar to this in NASS. The options that it opened up for us were invaluable.

Maniplus played a major role in many parts of the Agricultural Census. The Blaise call scheduler was used for the first telephone contact. Two Maniplus programs were developed to manage the special handling of forms with a TOC. One was for a second CATI contact and the other was for secondary non-CATI type of processing.

One of the specifications of the survey was to contact all refusals a second time, using a more experienced group of interviewers. Other examples of a second CATI contact included language barriers, claims by the respondent that the form was completed and returned but no form was received after a two-week period, and discovery of new correct phone numbers. Maniplus was used to develop a point and shoot interface (Figure 3) which could be sorted by the TOC. This grouped the similar types of contacts and allowed the experienced interviewers to know some history of the form. Upon selecting an id from the list, a dialog box was displayed with other pertinent information. From there, the interviewer could click on the Retrieve Form button, which would invoke the DEP, and the interview could be conducted.

Figure 3 Point and shoot interface



The other Maniplus program was geared for the statistician's use. It provided a similar point and shoot interface, but included a different subset of forms. This list could also be sorted by TOC. Examples of forms included in this list were second refusals, disconnected or incorrect phone numbers, six attempts to contact the respondent had been made, inaccessibles, and reported duplication. As with the secondary CATI interface, once an id was selected, a dialog box (Figure 4) was displayed with pertinent information. However, this dialog box used CONTROLS that could be edited. An FOC could be assigned, thus completing the case, without actually invoking the DEP.

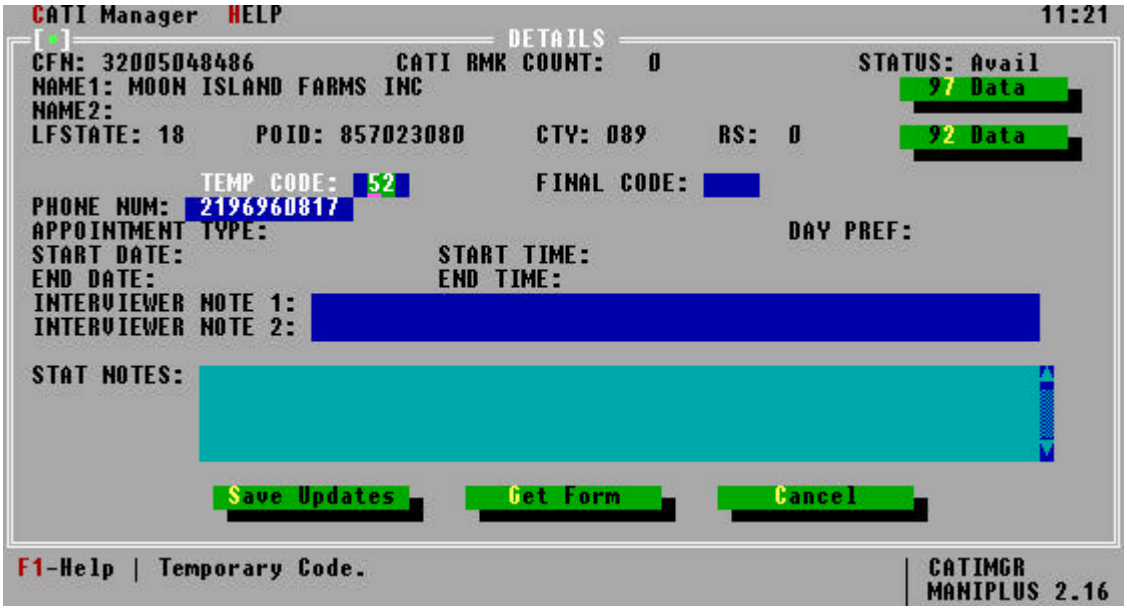


Figure 4 Dialog box with controls

Using Maniplus when Populating the Sample

On our more typical surveys, the name and address sample file is populated into a Blaise data set in its entirety. The Ag Census name and address files, however, were not as complete compared to what we are normally accustomed. Many records were missing phone numbers that would need to be looked up before populating them into the data set. Also, some of the applications had large samples of which only subsets would need to be populated at one time. For these reasons, it was evident that our procedures for populating a data set would need to be changed.

A Maniplus setup was written to handle the populate process. It did not use menus. It simply started with a dialog box prompting the user for an answer to the following question: "Are you adding records to an existing data set, or are you initializing from scratch?" If the user chose to start from scratch, two warning dialogs were invoked if the data set already existed. As a safety net, a batch file was run from Maniplus to make a backup copy of the existing data set. The user was then prompted as to whether all records in the provided ASCII input file should be populated, or just the records with a telephone number.

Before adding these forms to the Blaise data set, a procedure was invoked that assigned the appropriate time zone to each of the forms. To determine the time zone, this procedure first looked at the state field. Some states required that the county field also be considered to determine the time zone. In a handful of states, the county field was not sufficient, and so the zip code field was also examined. Parts of a couple of states do not take advantage of daylight-saving time, so the current date had to also be considered when time zones were assigned.

If the user chose the initialize process (versus the appending process), up to 200 forms were initialized into a practice data set. The names and the phone numbers were changed before the

data set was written. Interviewers can be trained prior to, as well as, during a survey using the live instrument with a practice data set. This newly created data set was also zipped for potential use, in the case of the 200 practice forms becoming exhausted.

Conclusion

As we look back on the uses of Blaise CATI on the 1997 Census of Agriculture, the one word that comes to mind is change. In the summer of 1997, we were planning for five CATI applications. Now as we look back on the completed effort, we can count seven. Four of the original five did occur and three other applications were born as the data collection effort evolved. The startup dates for some of the applications were also accelerated. Looking back on the CATI applications for the Census, it is amazing that we were able to consistently meet our target dates. Despite the number of new applications and ever accelerating schedules, the applications were up and running on time. Maybe even more remarkable is that almost no updates were made to the applications once they went into use. They worked from day one. Two factors can be credited here. First, the staff building and supporting the applications were extremely talented, experienced and dedicated. Many long hours, more than just a few off the clock, went into making this a success. The second factor is the flexibility and power of the Blaise system. We were able to build sound instruments that met almost every technical challenge. Utilities such as Maniplus allowed us to build user interfaces that could accomplish many tasks without even involving the instrument. The combination of a strong software in the hands of a gifted staff spawned success out of chaos.

The 1997 U.S. Residential Energy Consumption Survey's Editing Experience Using BLAISE III

Joelle Davis and Nancy L. Leach, Energy Information Administration (USA)

Introduction

In 1997, the Residential Energy Consumption Survey (RECS)Xone of the major energy consumption surveys in the United StatesXbegan collecting data using Computer Assisted Personal Interviewing (CAPI) techniques rather than the traditional Paper and Pencil Interviewing (PAPI) method. The move to CAPI was motivated by a corporate goal to decrease the time between the collection of data and the publication of results (in previous RECS, there was typically a two to three year lag), and still maintain the high data quality that has historically been associated with the survey. Additionally, a secondary goal was to choose a CAPI software program that allowed the questionnaire to be programmed by subject-matter program staff rather than systems designers.

The RECS is conducted by the Energy Information Administration (EIA), the independent statistical and analytic agency within the U.S. Department of Energy (DOE). Prior to selecting the CAPI software that would be used to program the RECS questionnaire, EIA previewed several CAPI software packages and determined that BLAISE best matched EIA=s requirements of a package that would not only affect how the data were collected, but would also impact the subsequent data processing steps, such as coding the responses, editing the data, and imputing for missing values.

This paper will focus primarily on the impact of the use of CAPI on three survey processing steps: the coding of comments, post-interview editing of the data and imputing for missing data.

Background

The RECS is a national statistical survey of households in the United States. The survey, which is mandated by the U.S. congress, is sponsored by the U.S. Department of Energy. RECS was conducted annually from 1978 to 1982 and then in 1984, 1987, 1990, 1993 and 1997. RECS collects detailed information about the physical characteristics of the occupied housing unit, the demographic characteristics of the household, the types of energy used in the home and detailed information about energy-using equipment and appliances. These data are collected during a voluntary on-site 30-minute personal interview.

Prior to the 1997 RECS, data were collected using PAPI. In 1997, data collection was changed to CAPI techniques using BLAISE III version 1.12. The questionnaire was programmed by technical (not systems) program office staff and contained a maximum of 348 questions with 29 range edit checks and 19 consistency checks imbedded within the questionnaire. These consistency checks consisted of both hard and soft edits. The 1997 RECS collected data from 5,900 households between April 1997 and August 1997, with a response rate of over 80 percent. Over 200 field interviews were trained to use the BLAISE III CAPI questionnaire.

CAPI Impact on Data Processing Steps

Comparisons can be made between the PAPI and CAPI versions of RECS at several stages during the data processing. These key stages are coding the comments, editing the data, and imputing for missing data.

Coding the Comments

Even though BLAISE III was used for the 1997 RECS, some manual coding was necessary in the cases where the interviewer had to key in an "Other/Specify" response or when the interviewer recorded notes in the comment fields. In both cases, the keyed responses had to be reviewed and judgements had to be made about how to code the responses. "Other/Specify" responses were recorded into CAPI during the interview. Following the interview, they were printed out along with the questionnaire wording and reviewed by coders who determined the appropriate response and then entered the response into the CAPI database. This CAPI coding process is many times more efficient than the PAPI coding method, in which editors were required to sort through stacks of questionnaires in search of comments that might need to be coded, at which point they would continue with basically the same steps as in the CAPI coding.

In the case of interviewer recorded comments in CAPI, the comments were printed out by questionnaire identification number and compared with the respondents' answers to relevant questions. Corrections were made if necessary and entered into the database. Table 1 shows that there were savings during the coding phase of the survey in terms of both staff level of effort and timeliness. The time needed to complete the coding was decreased by over seventy-five percent, so although it is true that the 1997 questionnaire was about one-half the size of the 1993 questionnaire, this is still a substantial savings in time.

Table 1. Comparison of Coding Effort, 1993 and 1997 RECS

ITEM	1993 RECS (PAPI)	1997 RECS (CAPI)
Staff Level of Effort	200 Person Days	45 Person Days
Number of Coders	3 Full-Time	1 Part-Time
Number of Supervisors	1 Full-Time	1 Part-Time
Elapsed Time from Beginning to End of Coding Task	3.5 Months	18 Days (5 Days for Other/Specify Coding, 13 Days for Interviewer Comment Coding)

Source: Energy Information Administration, 1993 Residential Energy Consumption Survey and 1997 Residential Energy Consumption Survey.

Post-Interview Editing

Range and consistency checks normally occur in a PAPI questionnaire after the field work is completed and all cases have been coded and entered into a database. In the 1993 RECS collected using PAPI, this editing task took approximately 6 months to complete. The Edit Plan, which identified and programmed every possible skip pattern and consistency check, began before the data were available. The plan was 250 pages long with about 50 editing programs. The multistep editing procedure consisted of printing a list of cases that failed a particular edit, printing a list of variables that would be helpful in resolving any inconsistencies, examining the paper questionnaire, determining the necessary corrections to the inconsistencies, recording any corrected information on the questionnaire and on the error listing sheets, and finally, refiling the questionnaires.

In 1997, with the use of CAPI, the post-interview editing was streamlined. Most importantly, many of the edits from the 1993 post-editing plan were incorporated as edits in the BLAISE questionnaire. Also, because the data were immediately available, editors and analysts could begin examining the frequencies and crosstabulations as the data were being collected. This enabled analysts to identify consistency errors during the early stages of data collection and to write and program edit specifications only for identified errors. The Editing Plan and programs were updated and modified, as necessary, throughout the data collection period.

The 1993 Editing Plan of 250 pages and 50 editing programs was reduced to approximately 20 pages and 6 editing programs in 1997. These 1997 edit programs produced lists of cases that failed a particular edit check. The editor examined the data and any interviewer comments that might help resolve the edit failures and determined the necessary corrections, which were then reentered into the CAPI database.

The actual savings in terms of person hours as they relate to the post-interview editing phase of the survey are difficult to determine, partly because of the differences in the way specific task hours were tracked in the 1993 and 1997 RECS, and partly because the survey instrument was shorter in 1997 and did not include a section that had required extensive editing in 1993.

Nevertheless, the fact that the data were immediately available to the survey contractor in 1997 was extremely beneficial. The CAPI data could be reviewed much earlier than the PAPI data, which, in turn, allowed identification of potential data problems during the data collection phase, rather than during the editing phase which previously had occurred after the survey was out of the field. Table 2 shows statistics for the 1993 and 1997 post-interview editing phase of the RECS.

Table 2. Comparison of Post-Interview Editing Effort, 1993 and 1997 RECS

ITEM	1993 RECS (PAPI)	1997 RECS (CAPI)
Staff Level of Effort		
Number of Editors	3	0
Number of Editing Managers	1	1
Number of Computer Programmers	3	1
Research Assistant	0	1
Elapsed Time from Beginning to End of Coding Task	5-6 Months	3 Months Interspersed With Other Tasks

Source: Energy Information Administration, 1993 Residential Energy Consumption Survey and 1997 Residential Energy Consumption Survey.

Imputing for Item Nonresponse

Item imputation is a statistical process used to generate values for missing items. It is designed to minimize the bias of estimates based on the resulting data set. In the RECS, missing data items were generally treated by a technique known as hot-deck imputation. In hot-decking, when a certain response is missing for a given housing unit, another housing unit with similar known characteristics (the donor) is randomly chosen to furnish its reported value for that missing item. The value is then assigned to the building with item nonresponse (the nonrespondent, or receiver). This procedure is often time-consuming and generally occurs after field work is completed and the data have been edited.

In the 1993 PAPI version of RECS, 378 variables were imputed. About 50 variables were missing data for 10 or fewer cases and about 40 were missing data for 100 or more cases. The vast majority of the missing variables were due to "No Answer" (that is, the interviewer did not record a response or the response was inconsistent with other responses), rather than a "Don=t Know" or "Refusal."

In comparison, the 1997 CAPI version of RECS had only 145 variables imputed. Over half were missing data for 10 or fewer cases and only 6 variables were missing data for 100 or more cases. Most of the missing data in 1997 was due to a "Don=t Know" or "Refusal" response. Because BLAISE does not allow a necessary field to be left blank, this source of error was eliminated. Table 3 provides imputation statistics for the 1993 and 1997 RECS.

Table 3. Comparison of Data Imputation Effort, 1993 and 1997 RECS

ITEM	1993 RECS (PAPI)	1997 RECS (CAPI)
Number of Household Questionnaire Items	559	348
Number Of Variables Imputed	378 (68 percent)	145 (42 percent)
Number of Variables Not Imputed	181 (32 percent)	203 (58 percent)

Source: Energy Information Administration, 1993 Residential Energy Consumption Survey and 1997 Residential Energy Consumption Survey.

Instrument design errors can occur during the use of both PAPI and CAPI. In the 1997 RECS there were some errors that occurred because of CAPI programming errors. However, whenever this type of error occurred, it occurred consistently. In a PAPI instrument, an error or lack of clarity in a questionnaire skip

instruction can cause discrepancies as to which follow-up questions are asked; each interviewer may interpret the instruction in a different way. In a CAPI instrument, however, programming errors cause consistent problems to occur in the data. For the 1997 RECS, in some cases the data were retrievable or correctable; in other cases decisions were made to ignore certain data items. Because the errors were consistent, it was easier to decide what could and should be done with the data when such programming errors occurred.

Summary

Both major goals–increased timeliness and high data quality–were met using BLAISE. In 1993, the elapsed time between data collection and EIA's first look at any data was approximately two months; in 1997, analysts were able to view partial data even before the interviewing was complete. The 1997 RECS data was actually published five months sooner than the 1993 RECS. Much of this increased timeliness was due to the fact that the RECS data collected in 1997 using the CAPI questionnaire were much cleaner than were the 1993 data collected using PAPI. The use of CAPI resulted in less nonresponse, and a considerable savings of time during the editing and imputation phases of the survey. Item nonresponse due to interviewer skip pattern errors was greatly reduced. There is little doubt that the built-in data edits nearly eliminated item nonresponse due to interviewer error. The hard and soft edits greatly reduced the number of inconsistencies in the data, thereby resulting in a much cleaner data set. When programming errors did occur, they occurred consistently throughout the 5,900 cases and allowed for consistent decisions to be made on how to handle the problem cases.

Based on the success of the 1997 RECS using BLAISE to program the questionnaire, the 1999 Commercial Buildings Energy Consumption Survey (CBECS), a more complicated survey with many more skip patterns, is currently being programmed in BLAISE 4 for Windows as a Computer Assisted Telephone Interview. This instrument is also being programmed in-house by an EIA technical analyst.

Section E. Organisation

Using Blaise in a survey organisation where the researchers write the Blaise datamodels

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CAI, starting with CATI, has been with us well over two decades. Most of the original questions it posed for survey organisations have been resolved[iii]. The kinds of organisations and the types of work for which it is most likely to be successful are well known[iv]. While most organisations have a range of CAI modes in their portfolios, to use as appropriate, some broad generalisations can be made. CATI and CASI, with rapid design, programming, implementation and reporting of simple instruments, are well established in the commercial field, particularly in the USA[v]. CAPI has so far seemed best suited for organisations which typically implement lengthy, complex instruments on social and economic topics for government and other parts of the public sector, and do so on a sufficient scale to justify a permanent staff of interviewers. Such justification is most likely if their portfolios include a number of regular or continuous surveys. This paper concerns one of the few remaining questions about CAI on which different survey organisations, including those which share many characteristics, retain different and strongly held opinions: what kinds of staff should author CAI instruments.

Under paper and pencil interviewing (PAPI), questionnaires were usually designed by the researchers who would eventually analyse the results themselves or who liaised closely with the customers' analysts to design questions and instruments to meet their analysis needs. Programming the routing of a paper questionnaire could be conceptually sophisticated, but its physical process was often a simple matter of using scissors and paste.

PAPI questionnaires included only very rudimentary interviewer's instructions and edit checks, if any at all, but we should note how these survey elements were dealt with since they were to become integral parts of the CAI instrument. Detailed interviewers' instructions were designed by some combination of researchers and fieldwork specialists. Interviewers were asked to study them ahead of the fieldwork and remember them in appropriate circumstances. Edit checks were, of course, carried out after the fieldwork was finished. They concentrated mainly on routing and ensuring that answers were within valid ranges, since errors of these types were possible at every question in the instrument. Data capture and editing was often carried out in third generation languages on mainframe computers. For all these reasons, edit checks tended to be a matter for computing specialists, with great variation between researchers in the degree to which they were involved. Looking at PAPI as a whole, including the elements which were already computerised before CAI, like editing and analysis, we can see a range of approaches to the division of labour between researchers and computing specialists. These approaches varied between organisations at any one time, and also within the same organisation over time. At one extreme, researchers simply specified their editing and analysis requirements to computer programmers. At the other extreme, researchers sought to extend their control of the survey process by specifying directly in higher-level languages like SPSS or SAS. Over time, as PCs spread in the workplace and PC software became increasingly easy to use, researchers have become accustomed to hands-on control in areas of the survey process which they may not have had in former years. For such researchers, CAI appeared a natural progression in their work with computers.

Computerisation of the questionnaire, and extension of the questionnaire to cover the functions previously carried out in post-fieldwork edit programs, posed a strategic issue for organisations (at least implicitly). Was this innovation to be regarded as essentially a development in the field of computing or as essentially a development in the field of survey design? Which of these two approaches an organisation settled on determined much of what followed in terms of the kinds of staff who were given responsibility for CAI policy and implementation. For example, on the key matter of choice of CAPI software, government and public sector organisations which saw CAPI as a computing matter (perhaps the majority) tended to favour writing their own bespoke software or to adopt CAPI packages which recognisably involved an approach similar to writing bespoke programs (these packages were often based on CATI software developed in an earlier computing generation). Commercial organisations were less concerned about a bespoke capability but their division of labour tended to leave even simple CAI packages as a matter for specialists. The government and public sector organisations which saw CAI as principally a matter for survey designers (researchers) tended to choose software which had essential functions built in (like the packages designed for commercial surveys, but with a much greater range of functions and a capacity to deal with complex data structures). The software had to demand no greater computing skills than their researchers already exercised in using statistical analysis packages like SPSS for manipulating data using logic as well as just running tables. To many such organisations, Blaise seemed to have been designed to meet their needs.

Many organisations saw CAI as essentially a computing development. This paper is about one of the organisations which saw it as essentially a development in survey design.

For such organisations, three main ways of working effectively have been identified:[vi]

- a team of researchers and programmers makes up an instrument design team for one or more surveys;
- researchers are trained as CAI programmers, and their skills kept fresh;
- researchers use standard modules and, where that is not possible, template modules to build questionnaires.

This paper describes why and how the author's organisation has used all three of these strategies since it began using CAI in production in 1990. It has moved increasingly towards the third strategy as the number of CAI surveys it carries out has expanded. The nature of the organisation is important for understanding the choice, so some brief details follow.

Social Survey Division and Blaise

Social Survey Division of the UK's Office for National Statistics (SSD/ONS) comprises some 190 headquarters staff and 1,000 interviewers (including about 200 telephone interviewers who work in a central CATI unit). The interviewers are recruited on a permanent basis, following successful completion of stringent recruitment and selection procedures, training and a trial period of six months. In contrast to the norm for commercial agencies in the UK, they are paid for time and expenses rather than by completed interview, and very few do any work for other agencies.

The headquarters staff comprise nearly 80 who are involved in aspects of fieldwork management and training (Field); over 50 researchers who combine project management with survey design, analysis and report-writing or who work in a methodology unit; about 30 computing specialists; and over 20 staff who provide sampling, management and secretarial support. At any one time, the work of the division covers 9 continuous surveys, including an omnibus survey, and various stages of some 40 *ad hoc* surveys, and a

range of methodological projects. Most, but not all, projects are household surveys, often involving interviews with all adults in the household. The two largest surveys together involve about half a million interviews with adults each year. Other surveys tend to be longer and more complex, and to involve smaller samples. Conventional enterprise surveys by mail or electronic means are carried out in a separate Business Statistics Group of ONS. The majority of SSD/ONS's work has been acquired through competitive tender. The surveys that SSD/ONS carries out are large-scale, usually complex, national studies for government and other public sector bodies. The uses of the survey results in designing and monitoring public policy make high quality essential. SSD/ONS clearly meets the criteria which were identified in the first paragraph of this paper for an organisation which has the basis for making successful use of CAI, and CAPI in particular.

Work is carried out in a project management structure, with each project team led by a researcher who is finally accountable for all aspects of the project. As it is researchers who write Blaise questionnaires in SSD/ONS, it is worth considering their characteristics more closely. Researchers are required to have a good (and, in practice now, often a higher) degree in a social science with substantial statistical content, statistics or mathematics; or to have demonstrated equivalent experience. Most are social scientists. While some have, or acquire, expertise in particular subject matter areas, it is SSD/ONS policy that researchers should be able to work on the full range of its surveys; in practice, movement between subject areas at the completion of each project, and between continuous and *ad hoc* surveys, is the norm in a researcher's career.

One result of the project management structure is that the researchers have always had hands-on knowledge and control of critical elements of the design and analysis, such as sampling, questionnaire and processing design, and statistical computing involved in the analysis. Under PAPI, there was already a tendency to try to eliminate duplication of tasks within the project team, such as specification of processing or analysis requirements to a programmer. This tendency was encouraged by software developments and by the need for programmers to take on more challenging tasks, to meet the needs of the organisation and their own careers.

As researchers had always designed paper questionnaires and were also seeking to extend their hands-on control of processing, it is perhaps not surprising that when CAPI became a real possibility in the mid-1980s SSD/ONS saw CAI questionnaire software as a tool for researchers. It quickly adopted Blaise because, in addition to its strong functionality and reliability, it was the only CAI software which had a fully integrated design. A single specification - in the familiar format of a questionnaire, though now incorporating edit checks - generated metadata which could be used unchanged from data collection (in any CAI mode) to analysis. That principle - signalled in the use of the general term *datamodel* for the enhanced questionnaire - was built on strongly in Blaise III and remains central to the appeal of Blaise to its users.

While it was important for researchers to take on direct specification of the instrument, it was equally important that they should not spend their time doing work for which they were not properly skilled and which it was more efficient for computing specialists to carry out. For example, SSD/ONS assigned the task of providing a suitable CAI environment of case management and telecommunications to its Survey Computing Branch.

In the early days of CAPI in SSD/ONS, there was a clear division of labour. At that time Blaise and Manipula were separate modules. Researchers used Blaise to write questionnaires and press-button Blaise utilities to output the data. If the survey was relatively simple, the output was read in SPSS and there was no need for any intervention by computing specialists. Usually, however, the survey would have a complex structure. In these cases, computing specialists read the output into their standard database software, Clipper, from where they could manipulate it into a suitable form for SPSS or, if necessary, send

it to specialist software for handling hierarchical data. They did not need to know anything about Blaise: it was policy for them to treat Blaise as a "black box".

This division of labour was relatively easy to operate when only a few surveys had converted to CAI. The number of researchers who needed to learn to use Blaise was small, and the pioneers were highly motivated. Moreover, most of the early CAI surveys were continuous surveys carried out by small teams of researchers who could sustain some collective knowledge of Blaise so that they were not dependent on particular individuals. However, from 1994 (by when the continuous surveys had adopted CAI) SSD/ONS's policy was that any new survey would use CAI unless there was a very good reason why it should not (such as that it was a qualitative study involving large amounts of verbatim reporting). By 1995, over 95% of SSD/ONS's interviews were carried out in Blaise. Any and every researcher now needed to be able to write Blaise instruments or, in the case of senior managers, to understand enough of the critical design issues to be able to supervise junior staff who were doing the actual writing.

With the integration of Manipula and Blaise in Blaise III, there were efficiencies in the computing specialists using Manipula rather than Clipper for many purposes. Moreover, data output was more flexible than in the push-button utility days of Blaise 1 and 2, but it was also more of a file-specification task appropriate for computing specialists. Use of Manipula and Cameleon by computing specialists entailed their learning about Blaise datamodels. Although Blaise was no longer a "black box" for computing specialists - and, indeed, they were clearly far more skilled than researchers in purely computing aspects of Blaise (e.g. making its functions perform more than they were originally intended for; linking in external programs; understanding how Blaise metadata could be accessed for an automatic documentation tool written in Clipper) - the basic division of labour was retained. Researchers designed survey instruments directly in Blaise. Computing specialists output the data, using Manipula and Cameleon, and continued to provide and improve the case management and telecommunications environment for CAI data collection.

A management review confirmed the policy that the researchers working on a survey should write its Blaise instrument. The review took particular account of the importance for survey quality of hands-on control and knowledge of the questionnaire by researchers. It also stressed the importance of co-operation in the survey team between researchers and computing specialists to ensure that the requirements for efficient output design were built into the datamodel by the researchers from the start. The review regarded the mode of working which involved researchers writing specifications for programmers to put into Blaise as involving duplication of resources and as potentially error-prone. It noted the difficulties reported by some organisations in recruiting and retaining programmers to carry out such (for them) mundane work[vii]. Finally, the review recognised that researchers would spend only a small and intermittent part of their careers writing Blaise questionnaires. This meant that there was a particular need for a cost-effective mechanism to ensure that researchers had the necessary up-to-date skills at the point that they were required; and that all Blaise questionnaires were of high quality. The remainder of this paper describes the mechanism that was set up.

Standards and quality assurance

The problem is to provide more than 40 researchers with a sufficient knowledge of Blaise for them to be able to use it as a tool to write high quality survey instruments, without undue cost or time in training and keeping the skills up to date. They should spend no more time than they do in, say, keeping up to date with analysis software. There are two main types of requirement for knowledge about Blaise. Junior researchers are likely to write all or most of the Blaise instrument code on their projects. Senior researchers need to know enough of Blaise and the critical factors in design using Blaise to be able to

supervise the juniors. The more senior the researcher the less need there may be to know the details of Blaise, but at the very least there is a need to know what may affect management decisions and strategy.

After nearly a decade of Blaise use in SSD/ONS, many senior researchers have experience in writing Blaise code from their junior days. However, it may some time since they last used Blaise. Other senior researchers do not even have this experience to build on. Brief guidance on "Blaise for managers" has proved sufficient for most senior managers if they have some former or background knowledge and will not need to write code themselves.

New researchers are recruited at all levels, though in largest numbers at the junior level. New recruits receive a 3-day course in Blaise, provided by Statistics Netherlands. This is enough to enable them to start to understand the complexities of real survey instruments, but there is a great deal to learn about Blaise as a tool in survey design and not simply as a programming language. Such skills are only learned in practice, so more courses are not the answer. At the same time, SSD/ONS has to provide secure means of delivering high quality Blaise instruments to carry out customers' surveys.

The strategy SSD/ONS has adopted is to embody the collective practical knowledge of the organisation in:

- a set of standards for writing Blaise code;
- standard code for common elements of questionnaires, such as the household box;
- and templates for writing unique questionnaire content into standard instrument structures.

Annex A is an extract from the document which explains this strategy and some of its detailed implementation to SSD/ONS's researchers.

Among its other benefits, the strategy simplifies the training requirement. Instead of learning and re-learning Blaise each time it is needed, the researcher needs to understand only some basic structural principles and conventions which can be summarised in a few pages. All the detail, in its most up-to-date form, using best practice, is available in the standard code and templates.

There are other significant advantages to this approach:

- supervision of new and junior researchers is simple and efficient, since it is clear to them and to their supervisors exactly what they should produce;
- researchers can read each other's code with minimal difficulty since it looks like the code they themselves would write, and uses the same conventions; this is important in an environment where researchers move between surveys and where several researchers will work together on the larger surveys;
- the screens which interviewers see have a standard format - they know, for example, where on the screen to find the current respondent's name (and it is guaranteed that the researcher will not forget to provide such standard information);
- the approach facilitates rapid development of reliable instruments by allowing researchers to build them, to a considerable extent, from standard blocks;
- it facilitates testing and SSD/ONS's quality assurance of its Blaise instruments.

The strategy requires a small team to lead, co-ordinate and publicise the setting of standards and the provision of quality assurance. The team, which is called the CAI Standards and Quality Assurance (SQA) team, comprises two researchers, a fieldwork expert and two computing specialists. Their jobs on the team are part-time, and the doubling-up of researchers and computing specialists is to ensure cover. The total time allocated to the team, to cover all its members, is well under one person year and is tending

to reduce. In the allocated time, the team develops new standard and model code, provides a trouble-shooting service (advice to, but not substantive work on, survey projects) and maintains its own expertise. The computing specialists check all new instruments for conformity to the standards, mainly by using automatic tools. The quality of the content, and its testing, remains the responsibility of the senior researcher on each survey.

Conforming to standards does not add time or cost to a researcher's task: it is the default option, embodied in the standard and model code that researchers start from. The standards would never be allowed to prevent a researcher from designing an instrument to function as they and their customers choose. In practice, the issue does not arise. Blaise needs to be written in some form, and the model code embodies a suitable one. It is easier to use the standard and model code than to invent a form of one's own.

The approach described in this paper has grown up over many years. The SQA team has only formally existed for two years, but there has been a CAI co-ordination role from the start. The approach has been re-examined critically several times over the years, but has always been reaffirmed as the best way to meet SSD/ONS's goals in survey design.

ANNEX A

STANDARDS AND CONVENTIONS FOR WRITING BLAISE III DATAMODELS IN SSD/ONS

Standards and Quality Assurance (SQA) team

Blaise III standards (document month: September 1997)

A standardised approach to CAI instrument design is one of SSD's strategies for helping designers produce instruments which meet the needs of their surveys as fast and as accurately as possible. It is the basis for preprepared modules of Blaise code (e.g. for harmonised questions) which can be slotted into any SSD survey, and for templates of Blaise code which can be adapted to any samples and subject matter. Standard modules and templates will save designers a lot of tedious and error-prone work which is associated with any programming task and allow them to concentrate on the real research issues. They will help interviewers by prompting designers to produce screen layouts with the information they need in the places where they expect to find it and with standard meanings. Many of the standards in this document are essential to the smooth running of survey instruments in the laptop and CATI computing environments. Standardisation is a means for an organisation, and not just individuals, to learn from experience and to generalise good practice.

….
The SQA team has drawn up the standards. It does not claim that these standards are the only viable way of doing things, but asks people to accept that the point of standardisation is to have a common way wherever possible and that these particular choices are based on experience of a wide range of surveys and of the problems raised by the differing styles of their designers. The process of instrument design will work best if the survey team meets with the SQA team before actually writing any code and agrees a strategy for the design, including the way standards will be used, and arranges any help that the SQA team can provide. Many surveys have already done this successfully ….

This document is for quick reference for designers who have at least a basic knowledge of Blaise. It is about SSD's standards for Blaise, not about any requirements of the software itself.

Questionnaire ("Datamodel"[7]) structure

A survey datamodel will comprise:

- one and only one datamodel control file (with a file extension .bla) (see Annex A.1) covering all requirements at datamodel level except the following paragraphs:
  RULES
  TYPE
  LOCALS
  AUXFIELDS

In the main, it will be a list of INCLUDE files, to bring in the paragraphs excluded above and the blocks for the survey. These INCLUDE files will have extensions .HAR (harmonised, not to be changed except with written agreement of SQA team) or (survey-three-letter-acronym (TLA) for example .GHS). In addition to the harmonised blocks, the SQA team will provide model files (extension .MOD) for researchers to use as templates for their own survey blocks (converting the extensions from .MOD to .(survey acronym); in the rest of this note, we refer to the modifiable files as .MOD but a survey will need to change this extension).

- INCLUDE files for the following datamodel level paragraphs:
  RULES.....RULES.MOD (see example at Annex A.2)
  TYPE .....TYPE.HAR and TYPE.MOD
  LOCALS.....LOCALS.HAR and LOCALS.MOD
  AUXFIELDS.....AUXFIELDS.HAR and AUXFIELDS.MOD

- INCLUDE files for the survey's blocks (ONLY 1 block or 1 block which contains nested blocks per file):
  harmonised blocks..... .....QSubject.HAR
  model/modifiable..... .....QSubject.MOD

It is very important to note that ONLY 1 block or 1 block which contains nested blocks is allowed per file. This is vital for efficient instrument design. For example, it allows the naming convention of the file and block having identical names, which facilitates instrument amendment (see below).
….

Blaise III does not allow CHECKS and SIGNALS to be separated off into their own INCLUDE files. This Blaise constraint means that the RULES paragraph at datamodel level is not, as we would like, just an outline of the routing. The CHECKS and SIGNALS should be put in carefully, in as organised and discrete a way as possible, so as not to clutter up the view of the routing. The model code RULES.MOD may be used as a template.

Naming/defining conventions

Datamodel control file.....survey acronym + surveyYEAR + version .BLA

[7] This Blaise term is intended to indicate that the specification for the questionnaire is much more than that - it is the metadata (data about the data) for the survey, used at all stages from data collection to analysis.

(e.g. SEH9601A.BLA, OMN9702B.BLA)

INCLUDE files exactly same as field name of block in each
(e.g. QTCalls is in QTCALLS.MOD; the rules for the datamodel are in RULES.MOD). This means that names of blocks should be no more than 8 characters (the DOS limit) even though Blaise allows more.

Blocks .....start with B (e.g. BPerson)
.....field name of block starts with Q (e.g. QPerson)
.....table blocks start with T (e.g. TPerson)
.....field name of table block includes the T
(e.g. QTPerson)
.....Block field names are always defined in the INCLUDE file they belong to, NOT in the datamodel FIELDS paragraph.

Locals .....with 1 or 2 standard exceptions (the current list is at ..), names will comprise the name of the block in which they are defined, with L in front
and a number at the end (e.g. LPerson1, LPerson2 would be the ones defined in BPerson; LTPerson1 would be found to be defined in TPerson). Datamodel level locals will be called LDM1, LDM2, etc.
(Reason: so-called intuitive names are frequently misleading or not actually intuitive for another reader. What one needs to know is where the local is defined. Then the reader can find out what it's actually doing.)

Derived variables .....Computed variables stored on file (i.e. computed into fields) must start DV

Paragraph commands .....FIELDS, AUXFIELDS etc - must ALWAYS be accompanied by a commented reference to the block they are in, e.g. RULES { TPerson}

Labels..... Labels can be used to provide precise comments which have a reasonable chance of being updated (i.e. it's a project responsibility) since they are part of the survey metadata,
e.g. on blocks
Block BPerson "Main person Information Block"

……..

Standard files and blocks

….details of standard configurations to ensure that testing on office PCs mimics accurately the configurations on interviewers' laptops……

(an example…..)

Permission to recall block (QRecall.HAR)

There is a standard block for asking for permission to recall. Your datamodel control file should INCLUDE it as follows:

INCLUDE O:\B3115\SQA\MODULES\QRecall.HAR

This guarantees that you will use the latest version. If you wish to use something else, you should have written agreement from the SQA team.

Annex A.1 - Datamodel control file example.

```
{TM020297  ********************************************************
* GLC97nn - DATAMODEL CONTROL FILE for GENERAL LIVING CONDITIONS SURVEY
* 1997 (the Blaise III Field training questionnaire)

* GLC97nn.BLA - this file - contains INCLUDE files for whole
* questionnaire.
*
* It does NOT contain TYPES, LOCALS, AUXFIELDS or RULES - see
* include files TYPE.HAR, TYPE.GLC, LOCALS.HAR, AUXFIELD.HAR,
* AUXFIELD.GLC and RULES.GLC respectively.
*
* RULES.GLC must be the final include file before ENDMODEL.
TM020297      ********************************************************}


DATAMODEL GLC9704

LANGUAGES = ENG "English", HLP "Instructions"

ATTRIBUTES = DontKnow, Refusal

PRIMARY

  QID

PARALLEL

  QReCall
  QHAdmin

USES { DM ************************************************************}

{TM301296*************************
* check for valid SOC codes
TM301296}

  SocMeta 'C:\CASEBOOK\COMMON\EXTSOC',

{TM301296*************************
* classification matrix
TM301296}

  MatMeta 'C:\CASEBOOK\COMMON\EXTMAT',

{TM301296*************************
* subject of qualifications - from LFS - see also LIBRARIES para (note
* slightly different name there: Subjects (plural)
TM301296}

  Subject 'C:\CASEBOOK\GLC\SUBJECT',

{TM301296*************************
* nationality - from LFS
TM301296}

  Nation 'C:\CASEBOOK\GLC\NATION'

{TM301296*************************
* END OF USES {DM} PARAGRAPH
```

```
TM301296*************************************************************}

LIBRARIES { DM ***********************************************************}

{TM200296************************
* subject of qualifications - from LFS - see also USES para (note
* slightly different name there: Subject (singular)
TM200296}

  Subjects 'C:\CASEBOOK\GLC\SUBJECTS'

{TM200296************************
* END OF LIBRARIES {DM} PARAGRAPH
TM200296*************************************************************}


INCLUDE "QID.HAR"
INCLUDE "QDATABAG.GLC"
INCLUDE "TYPE.HAR"
INCLUDE "TYPE.GLC"
INCLUDE "LOCALS.HAR"
INCLUDE "LOCALS.GLC"
INCLUDE "AUXFIELD.HAR"
INCLUDE "AUXFIELD.GLC"
INCLUDE "QSIGNIN.HAR"
INCLUDE "QNAMES.HAR"
INCLUDE "QTHCOMP.HAR"
INCLUDE "QHOH.GLC"
..
..
INCLUDE "QTENURE.HAR"
INCLUDE "QECSITU.GLC"

{TM080197
START OF ADULT INCLUDE FILES
TM080197}

INCLUDE "QTISTART.HAR"
INCLUDE "QTILO.HAR"
INCLUDE "QTWANTJB.GLC"
INCLUDE "QTLASTJB.GLC"
INCLUDE "QTMAINJB.HAR"
INCLUDE "QTEMPLEN.HAR"
..
..
INCLUDE "QTINCEMP.GLC"
INCLUDE "QTINCSE.GLC"

{tm200697  ***********************************************************
* The next file "QRECALL.HAR" asks for permission to recall
* and collects contact details
TM200697}

INCLUDE "QRECALL.HAR"

{tm010197  ***********************************************************
* The next file "QHADMIN.(surveyname)" is the one that Social Survey
* Division calls the "ADMIN BLOCK".
* It contains 3 INCLUDE files: "QFAMUNIT.HAR","QTOCC.HAR" and
* "QTCALLS.HAR"
TM010197}

INCLUDE "QHADMIN.HAR"
```

```
{tm160197  ********************************************************
* The next file "RULES.(surveyname)" must be present and must be the last
* include file.
*
* "RULES.(surveyname)" contains the 2 datamodel level CHECK
* paragraphs - (1) harmonised (2) model (i.e. survey-specific).
* Note that these CHECK paragraphs cannot be held in INCLUDE files.
tm160197}

INCLUDE "RULES.GLC"

ENDMODEL
```

Annex A.2 - Example of a file containing a block.

```
{TM010197
* This file (QNames.HAR) sets up an array in which the names or other
* identifiers for household members can be entered in any order, in response
* to question "Who lives here?" (asked in QSignIn).  Household reference
* person, if needed, can be identified later, in a question or by a compute.
*
* ONLY ONE THING CAN BE ALTERED IN THIS FILE - AND ONLY WITH AGREEMENT OF
* STANDARDS AND QA TEAM - (THE ARRAY SIZE AT …)
tm010197}

BLOCK BNames

  LOCALS { BNames }

     LNames1, LNames2 :  INTEGER

  BLOCK BBNames

     FIELDS { BBNames }

        Name     "RECORD THE NAME (OR A UNIQUE IDENTIFIER) FOR HOH,
                 THEN A NAME/IDENTIFIEER FOR EACH MEMBER OF THE
                 HOUSEHOLDúúúúúHELP<F9>@/@/
                 WHEN ALL HOUSEHOLD MEMBERS HAVE BEEN ENTERED, PRESS
                 PgDn@/"

                 "PRIMARY SET OF QUESTIONS ON HOUSEHOLD COMPOSITION
                 AND RELATIONSHIPS ASKED ON ALL SURVEYS.@/@/
                 HOUSEHOLD COMPOSITION@/@/
                 Stage 1: Establish Residency - only/main residence 6
                 month rule/ Check Adult Children@/
                 Stage 2: One or more households - 'Do you all share
                 at least one main meal a day or share living
                 accommodation?'@/
                 Stage 3: Establish HoH - 'In whose name is the
                 accommodation owned or rented?'@/"

                 : STRING[12],EMPTY

     RULES { BBNames }

        Name

  ENDBLOCK { BBNames }

  FIELDS { BNames }

     QBNames  :  ARRAY [ 1..10 ] OF BBNames
     DVHsize    :  1..10,EMPTY

  RULES { BNames }

     LNames2  := 0
     FOR LNames1 := 1 TO 10 DO
        QBNames[LNames1]
        IF QBNames[LNames1] <> EMPTY THEN
           LNames2 := LNames2 + 1
        ENDIF
     ENDDO
     DVHsize  := LNames2
```

```
     DVHsize.KEEP

ENDBLOCK { BNames }

FIELDS  { DM }

  QNames :  BNames
```

[i] A recent summary of the state of the art in CAI is to be found in Couper, M. et al (eds) *Computer Assisted Survey Information Collection*, 1999, John Wiley & Sons Inc, New York.

[ii] See in this volume: Wings, H. *Blaise for the Internet.*

[iii] *The History and Development of Computer Assisted Survey Information Collection Methods*, Couper, M.P. & Nicholls, W.L. in M.P. Couper et al. (eds) 1998

[iv] *Development and Implementation of CASIC in Government Statistical Agencies*, Clark, C.Z.F., Martin, J. and Bates, N. in M.P. Couper et al. (eds) 1998

[v] *Integrating CASIC into Existing Designs and Organizations: A Survey of the Field*, Groves, R.M. & tortora, R.D. in M.P. Couper et al. (eds) 1998

[vi] *Producing CAI Instruments for a Program of Surveys*, Pierzchala, M. & Manners, T. in M.P. Couper et al. (eds) 1998

[vii] *Computer Aided Interviewing: Has It Ever, and Will It Still Work?* Connett, W.E. in Association for Survey Computing, Proceedings of The Second ASC International Conference, London,1996