

# AN OPERATIONAL TEST OF FAX FOR DATA COLLECTION

Richard J. Rosen and Richard L. Clayton, Bureau of Labor Statistics  
Richard J. Rosen, 2 Massachusetts Ave. NE, RM 4860, Washington, DC. 20212

**Key Words:** Nonresponse, Touchtone Data Entry, Automated Collection

**Background:** The Current Employment Statistics Survey (CES) is a monthly survey of over 380,000 business establishments. The survey collects information on employment, payroll, and hours. As its name suggests, the hallmark of the survey is its timely collection of information. In general, there are about 12 collection days available prior to tabulation and publication of estimates. Because of this compressed cycle, it is critical that every effort be made to collect information from each respondent.

Until recently, data collection was almost exclusively via mail. Under mail collection, response rates for preliminary estimates are about 50-55%. In an effort to improve response rates and, thus, reduce revisions between the preliminary and subsequent estimates, BLS has embarked on a long-term program to introduce various automated collection methods into the CES. [Werking and Clayton, 1991]

In 1985, BLS introduced Computer Assisted Telephone Interviewing into the CES. In 1986, automated self-reporting using a touchtone phone was introduced. This method, referred to as Touchtone Data Entry (TDE), allows the respondent to use the touchtone pad on their phone to dial a computer and report the data. Currently, over 20,000 businesses report each month using the TDE system. Response rates under automated collection average 80-85%.

While TDE reporting yields much higher response rates than mail, it is essentially a "self reporting" collection method--respondents must call in on their own. To assist respondents in the reporting process, BLS currently mails an "advance notice" postcard to each respondent at about the time their data are normally available. This postcard notifies the respondent that the reporting period is approaching. As the cutoff for receipt of data for preliminary estimates approaches, interviewers place short nonresponse prompt (NRP) "reminder" calls to units who have not yet reported.

Previous research has shown that about 60-70% of respondents will self-report. [Rosen, Clayton, and Rubino, 1991] The remaining units must be contacted by interviewers via the "reminder" or NRP call. While BLS has developed an optimization model to spread these calls out over a 5-day period, they still constitute a substantial workload and cost.

This paper looks at the use of Facsimile (FAX) communication as a substitute for the advance notice postcard and the telephone reminder NRP call. Both methodological and technical issues as well as performance and cost are discussed.

**FAX Technology:** In the past, FAX machines were very expensive and transmission quality was poor. However, over the past 10 years there have been major improvements in FAX technology, with vastly improved quality and reduced cost. A FAX machine can now be purchased for under \$500. This has made purchase of a FAX machine feasible and beneficial even to small businesses.

Another major breakthrough in FAX technology is the development of FAX boards that reside in PC's. These PC-FAX boards can send a file stored on the PC to another FAX machine. This makes it possible to read data bases and other files, perform comparisons, and generate a message based on the results.

**Methodological and Technical Issues:** The use of FAX for survey purposes posed a number of methodological and technical issues. While it appeared that a substantial percentage of establishments had FAX machines, the percentage of CES respondents with a FAX machine was unknown. Second, would respondents be willing to provide their FAX phone number and allow us to send the advance notice and NRP messages? How would respondents react to receiving these messages? Would they be as likely to report after receiving a FAX as compared with a telephone call? Would there be any long-term change in reporting behavior for units receiving a FAX as opposed to a personal telephone call; would units continue to respond to the FAX or begin to ignore it?

There were also a range of hardware and software issues to be addressed. For example, could existing FAX boards and software provide sufficient functionality to allow customized messages to be sent to respondents? What were the cost and workload factors involved in using FAX on a large-scale basis?

Our desire was to make the FAX system as automated as possible. We also wanted the system to operate in "background" so that TDE collection could proceed at the

same time that FAX messages were being sent. This was important since respondents expect the TDE system to be operational 24 hours a day, 7 days a week. The system also had to have the capability to capture management information such as the number of messages sent, outcomes, time of transmission, etc. so that we could monitor system performance.

**Pilot Test:** To answer these questions, BLS conducted a small pilot test. One state, Maine, was selected, and a portion of its existing TDE sample surveyed to ascertain the availability of FAX machines and willingness to receive FAX messages in lieu of the traditional mail advance notice postcard and telephone reminder call. At the same time a "control" group was selected for comparison. Figure 1 outlines the structure of the test.

The FAX and test panels were selected based on the last digit of the unit's report number. This provided for an essentially random distribution (as report numbers are assigned chronologically as each unit enters the sample) and facilitated tracking of the groups. Under the test procedures, BLS-Washington assumed responsibility for the FAX portion of the sample, while the BLS-Boston Regional Office assumed responsibility for the Control Group, and Maine retained collection of the remaining units. Figure 2 compares the distribution of the FAX and control groups by size of firm.

The panels were phased in over a two-month period from November 1991 to January 1992, with a test and control panel introduced in November and a second test and control panel introduced in January. This allowed us to gain some experience with the technology and provide additional time to fully develop systems and procedures.

As can be seen, the initial panels were very similar with regard to number of units selected and size of firm. The panels were also balanced with regard to length of pay period. Previous research has shown that size of firm and length of pay period are major determining factors in timely reporting.

**Results:** The following sections discuss various aspects of the results. This includes a discussion of response rates as well as hardware and software performance.

**Availability of Fax Machines:** About 80% of the units in the test panel had FAX machines that were convenient to them and were willing to participate in the test (see Figure 3). There is evidence that small firms, those with less than 5 employees, are less likely to have a FAX machine. This was the only group where the incidence of FAX was below 75 percent.

**Response Rates:** Over a 5-month period, the overall response rates for the two groups were very similar, 86

percent for FAX and 79 percent for the control group (Figure 4). This suggests that the use of FAX for both Advance Notice and NRP may be a reliable substitute for the current Advance Notice postcard and telephone NRP. The sections below discuss the results achieved for each stage of contact.

**Advance Notice:** For both groups the advance notice postcard or FAX message was sent to each sample unit on a fixed day. FAX messages were sent approximately 8 days prior to the cutoff for data receipt and postcards were sent several days earlier so as to reach respondents at about the same time as the FAX message.

Figure 5 summarizes the effectiveness of FAX advance notice compared with the postcard. Effectiveness is measured by the proportion of units which called in their data after the initial contact (postcard or FAX) but prior to the second contact (telephone or FAX).

These results show FAX to be very effective in obtaining cooperation from respondents. Indeed, 15-20% more units in the FAX group reported on their own than the control group which received the postcard. This suggests that FAX may be a better "eye catcher" than a postcard. This conclusion is similar to the results reported by Tulp and Hoy when comparing the effectiveness of regular mail versus certified mail for nonresponse follow-up [Tulp and Hoy, et. al., 1991].

Several caveats should be mentioned. First, the timing of postcard mailout may not have been optimal; that is because of mail lags, some respondents may not have received their postcard. Second, the results for April are somewhat overstated because all FAX nonresponse prompt messages were sent on Thursday rather than staggered based on the NRP model, while the telephone prompts were staggered. Thus, some units that would have received a FAX prompt because they were delinquent on Monday, Tuesday, or Wednesday did not receive the prompt if they reported before Thursday. Still, there is evidence that FAX worked better than the Advance Notice postcard, as all differences in Figure 5 are significant at the .05 level.

**Nonresponse Prompting:** During the first 3 months of the test, NRP FAX messages were sent on Wednesday, 3 days prior to the cutoff for data receipt. Beginning in the fourth month of testing (February 1992) additional programming was put in place to allow the FAX messages to be sent each day using the same algorithm used for the interviewer NRP calls. This provided a more accurate comparison between the two methods since each non-responding unit was treated the same in terms of the timing of the follow-up effort.

Figure 6 shows the effectiveness of the nonresponse prompt. The measure of effectiveness is the proportion of units reporting their data after the prompt (FAX or telephone) and prior to the cutoff for preliminary estimates. Over a five-month period, telephone calls to nonrespondents appear in

some months to be more effective than FAX in eliciting a response. However, none of the differences are statistically significant. The small sample size for the FAX NRP message which resulted from the differential response to the initial FAX Advance Notice makes any direct comparisons between the two groups problematic. Again, the April disparity reflects in large part the late send-out of FAX messages.

Even if this differential proves significant under larger scale testing, such a difference may be expected. First, one would suspect, a priori, that a direct telephone appeal would have some additional effectiveness than a message. Second, the positive differential effect of FAX over the postcard during initial contact may mean that the remaining FAX NRP units are "harder to collect" than those remaining for NRP follow-up via telephone. Additional testing on this question needs to be conducted where the initial contact method is the same for both groups in order to eliminate any bias from the first contact.

What is clear is that the combined effect of FAX Advance Notice and FAX NRP yields essentially the same response rate as the current postcard/phone call scenario.

**Hardware/Software Development:** In considering the use of FAX, there were several features which we felt were critical to successful operation. These included:

- 1) unattended operation, so that a large number of messages could be transmitted by simply initializing a program;
- 2) background operation, so that the PC would remain on-line to receive incoming TDE calls while FAX messages were being transmitted;
- 3) automatic retrying of unsuccessful FAXes;
- and 4) the ability to log call outcomes for future tracking.

Prior to the test, several PC-FAX boards were evaluated. The FAX board chosen was GAMMAFAX, manufactured by Gammalink, Inc. The hardware/software has been sufficiently comprehensive and flexible to perform the functions we had anticipated. Interface programs were written in Dbase/Clipper and "C". An initial system was developed in about one month. Then, over the first 3 months of the pilot, the programs to process and send the FAX messages became more robust. The current system prompts the user to input several controlling variables such as the reference month, the type of message (Advance Notice or NRP), and whether to send messages only to nonrespondents for a particular day of the week. After receiving this input, the system automatically compares the units in the TDE data file for the specified month against a master file. If a unit has not responded for the desired month and has a FAX number, then the appropriate message is sent.

Management information is captured automatically and stored in a rolling 12-month monitoring file. In addition, the system produces management reports after each set of FAX

transmissions detailing the number of messages sent, transmission duration, the number of "tries" required, and the resulting reasons for non-transmission.

The FAX board was installed on an IBM-PC model AT running at 10mhz. A faster processor would only marginally improve performance, since transmission speed is determined by the baud rate on the FAX board (9600) and the receiving FAX (which may vary from 1200-9600 baud). Functions such as creating the image for transmission and logging information on call outcomes to the various files will benefit from the increased speed.

**Transmission Time:** Two measures of transmission time were calculated, total time per unit and phone time per unit. Both measures are important. Total time represents the total amount of time needed to send a group of FAX messages. This time includes transmission time as well as other processing functions. It also includes the time required to process second or third submissions. Phone time represents the actual "connect" time to send the FAX. Total time is important in estimating workload, while telephone time is important in estimating operating costs.

The average total time was 70 seconds, while the average transmission time was 38 seconds. These figures were stable across months, type of message sent, and individual units.

Using these figures, it is estimated that about 625 messages could be sent during a 12-hour period. This would correspond to the hours between 6 PM and 6 AM. While the FAX system works simultaneously with TDE, sending messages during off hours avoids sending messages to individuals who may report while the transmissions are being processed.

Using a faster PC or adding an additional FAX board would increase the number of messages. With an eventual average TDE sample of 1,500-2,000 per State, these measures might be required for the Advance Notice message. Alternatively, these messages could be staggered over a number of days (as are the NRP messages). Nonresponse prompt messages could easily be handled with the single board, since NRP messages are sent to only about one-third of the sample and are staggered over a 5 day period.

**Number of Attempts:** Also of interest is the number of attempts required to complete FAX transmissions. Eighty-four percent of transmissions were completed on the first attempt. After two attempts, 92 percent of the transmission were successful, and, after 3 attempts, 94% of the transmissions were successful. Those that failed were re-submitted later in the day or the following day.

Unsuccessful attempts may occur because the receiving FAX line is busy, off-line, out of paper, etc. If the message fails because of a busy signal, then a second

transmission several minutes later will likely succeed. However, if the transmission fails because the machine is off-line, out of paper, or malfunctioning, subsequent attempts will likely be unsuccessful. This is especially true when transmitting during evening hours.

One minor difficulty was encountered for a small segment of the units. In a few instances, the FAX installation at the establishment required that an operator manually switch a phone line from voice to FAX mode. For such units a FAX cannot be sent after normal working hours. We encountered 4 such instances.

**Timing of Response:** Another measure of effectiveness is the timing of response. Figure 7 compares the proportion of responses which occurred after one, two, or three days from the NRP message. For the first two days, the proportions are virtually identical. There appears to be some drop-off in day three and beyond, resulting in a slight advantage to the telephone call. However, as noted earlier, these differences were not statistically significant.

**Respondent Follow-up:** To determine respondent reaction to receiving the FAX messages, a group of respondents were contacted by phone to elicit their reaction to the FAX messages. A total of 20 interviews were conducted, 10 with units which were sent only the Advance Notice (because they reported prior to the NRP message) and 10 with units which had received both the Advance Notice and NRP messages.

While the number of interviews conducted was relatively small, it was felt that any significant problems with the messages or procedures could be identified.

Overall, respondent reaction was very positive. All respondents indicated that it was convenient to receive the FAX message and that they encountered no delays in receiving the message within the establishment. Respondents rated the quality and appearance of the transmissions as either "very good" or "good".

When asked whether they preferred to receive the messages by FAX (compared with mail for the advance notice or telephone for NRP), most indicated FAX or no preference.

A final question asked whether they felt the FAX message was "more effective", "as effective", or "less effective" than the postcard or telephone call. Generally, respondents rated the FAX message more effective than the Advance Notice postcard (with none indicating it was less effective). On the effectiveness of FAX for NRP compared with the telephone reminder, there was more divergence. Some respondents felt the telephone call was more effective.

**Cost Comparisons:** FAX offers a potential cost advantage over other means of respondent contact. Figure 8 compares the cost of FAX to mail and telephone. FAX offers a 1/3 cost

saving compared to mail and a 3:1 cost advantage relative to a phone call. Compared with mail, the cost of the postcard alone exceeds the total cost of the FAX, while contacting respondents by telephone incurs substantial labor costs which are largely avoided under FAX.

**FAX Implementation Options:** Based on these results, BLS is currently evaluating the role of FAX for nonresponse prompting. Several options are under consideration. These include:

1) FAX only to units expected to report early in the collection week. This would allow time for telephone follow-up prior to the collection deadline. Under this scenario, about 60 percent of the sample would be eligible for a FAX message.

2) FAX only to units who generally report on their own. About 50% of the sample reported on their own (without a prompt) for 3 consecutive months. Another 23% required a prompt in only 1 of three months. FAX may be more appropriate for these groups.

3) FAX only to smaller units in the sample (ie. units with less than 100 employees). This would be justified on a cost/quality basis, since larger units are more critical for estimation and currently have lower response rates than smaller units regardless of collection method.

**Future Research:** Several areas of research need to be pursued. One principal area is a more definitive test of the relative effectiveness of FAX versus telephone for NRP. Another area for investigation is an analysis of longer term effects. Although sample units were not explicitly told this was a test, there may be some Hawthorn effect just by virtue of using such new technology. Also, as FAX becomes more ingrained into the business culture, will it eventually be treated like mail, negating some of its effectiveness?

One of the benefits of telephone follow-up is that it provides a link between the survey and the respondent. The telephone call becomes a vehicle for answering questions and exchanging information, such as changes in contact name, phone number, etc. Will complete elimination of this personal link have any long-term effect on response rates or other aspects of survey operation? Finally, the test results should be confirmed by a larger scale test in a different State.

**Conclusion/Recommendations:** FAX machines are widely available and used throughout the private sector. This makes the use of FAX a viable, convenient, and cost effective option for respondent contact for establishment surveys. Respondent acceptance of FAX is quite favorable.

Hardware and software are currently available to perform the desired functions. In addition, the technology is advancing rapidly. This will likely expand the potential scope

for FAX as well as improve its overall performance, resulting in an increased cost advantage.

One possibility for the future is to combine FAX with character recognition. This would make it possible to collect data directly from respondents via FAX rather than by mail. For example, instead of mailing out the collection form each month, the respondent could receive a FAX of the collection form. They would enter their data for the current month and FAX the form back to the PC-FAX board. The data would then be translated into machine readable form and feed directly into the estimation system (eliminating key entry). Such a system would not only be more cost effective than mail, it would also increase response rates, since the mail delay would be eliminated. It is estimated that 6% of mail forms are received 1-3 days after the preliminary cutoff date. If FAXed, these forms could be included for the preliminary estimates.

While hardware and software for character recognition on PC's is still in the developing stages and is costly, it is likely that such technology will develop rapidly in the next few years.

**References:**

Werking, George S, and Clayton, Richard L., "Enhancing Data Quality Through the Use of Mixed Mode Collection", *Survey Methodology*, June 1991, Vol. 17, No. 1.

Rosen, Richard J., Clayton, Richard L, and Rubino, Thomas B., "Controlling Nonresponse in an Establishment Survey", American Statistical Association, 1991 Proceedings of the Section on Survey Research Methods.

Tulp, Daniel, Hoy, Easley, et. al, "Nonresponse Under Mandatory vs. Voluntary Reporting in the 1989 Survey of Pollution Abatement Costs and Expenditures", American Statistical Association, 1991 Proceedings of the Section on Survey Research Methods.

**Acknowledgment:**

The authors wish to acknowledge the contributions of Lynda Wolf, who performed much of the statistical tabulation and analysis, and Vinod Kapani, who was responsible for the systems design and programming.

**Figure 1. Structure of FAX Test**

Purpose of Contact:	Method of Contact:	
	Control Group	Test Group
Advance Notice: Reminder to report when data are available	Postcard	FAX Message
Nonresponse: Request to report ASAP	Telephone call	FAX Message

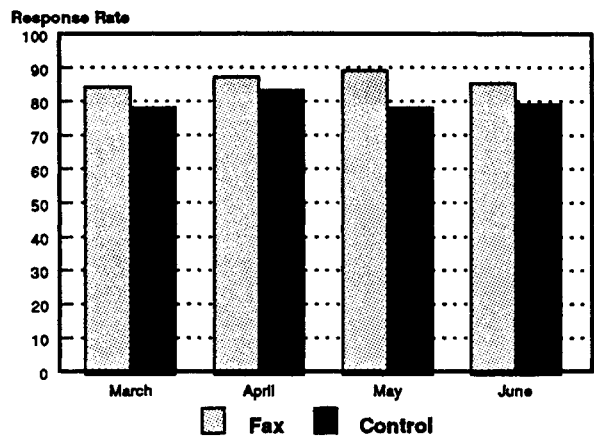
**Figure 2. Comparison of FAX and Control Groups by Size of Firm**

Size of Firm:	FAX	Control
	Percent	Distribution
Less than 5 employees	11%	14%
5-9	20%	21%
10-19	26%	31%
20-49	21%	12%
50-99	9%	14%
100-249	7%	7%
250+	6%	1%
Sample Size	165	148

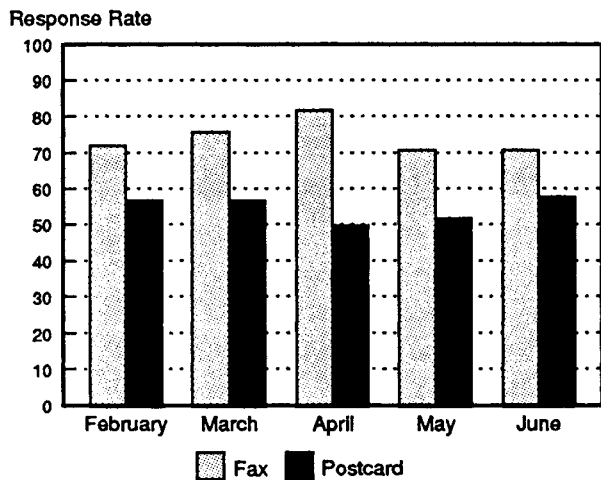
**Figure 3. Availability of FAX Machines by Size of Firm**

Size of Firm:	Percent
Less than 5 employees	50%
5-9	76%
10-19	77%
20-49	89%
50-99	100%
100-249	83%
250+	89%
Total	79%

**Figure 4. Response Rate for Initial Estimates**

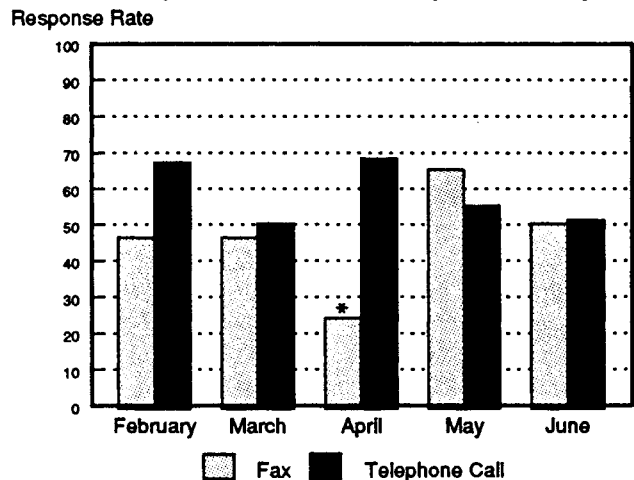


**Figure 5. Effectiveness of FAX Versus Postcard for Advance Notice**



- Differences significant at .05 level

**Figure 6. Effectiveness of FAX Versus Telephone Call for Nonresponse Prompt**



\*All NRP for April were made on Thursday

**Figure 7. Timing of Response to NRP Message**

	FAX	Telephone Call
1 Day	42%	41%
2 Days	5%	6%
3+ Days	2%	10%
No Response	51%	43%

**Figure 8. Cost Comparison: FAX, Mail, Phone**

Item:	Unit Cost of Contact:		
	FAX	MAIL	PHONE
Phone Charges	\$0.15 <sup>(1)</sup>	----	\$0.22 <sup>(2)</sup>
Postage	----	\$0.19	----
Printing	----	\$0.03	----
Labor	\$0.01	\$0.02	\$0.33 <sup>(3)</sup>
Total	\$0.16	\$0.24	\$0.55

(1) 40 seconds per FAX at 22 cents per minute.

(2) 60 seconds per call at 22 cents per minute.

(3) 30 calls per hour at \$10.00 per hour.