AN INTERVIEW SURVEY OF STATE FAIR GOERS

C.H. Proctor, North Carolina State University

1. BACKGROUND

As a class exercise in sample survey design and execution, a group of students counted and interviewed a portion of the exiting fair goers during North Carolina's 1969 State Fair. Aside from this intrustion of the classroom into the society, the survey can be counted as a realistic attempt to sample and measure people's reactions to recreation experiences, so that describing it might be of some interest.

The fair management had been looking at reports of other fair surveys and thinking about their own needs so that, when requested, they drafted a questionnaire form that incorporated some of their special interests as well as the more conventional material. This is a most painless, as well as concise, way to have the client express the purposes of the survey. Some marginal adaptations of the form were made so that it could both be self-administered as well as presented by the interviewer, depending on the circumstances.

Another early decision was similarily disposed of with ease, and that was the sample size or, in this case, the size of the budget for the survey. There were 18 people in the class who could each be asked to do one hour of interviewing at two different times during the 9 days of the fair. The instructor (the writer, that is) felt this to be a reasonably just assignment in that it provided actural enumerating experience, without undue exploitation.

2. FRAME CONSTRUCTION

The issue of most concern in early planning of the sample design was the choice of the sampling unit and enumeration procedure. Interviewing on the fairgrounds was ruled out because of the possible biasing influence of traffic patterns, and thus it was decided to interview people as they left the fair. Just outside the fairground's gates one faces an outgoing stream of persons grouped into parties. The stream's density rises and falls from time to time and varies from gate to gate. The fair's management gave their judgements of times of the day when the stream increases. These were the afternoon from 4 to 6 and the evening from 9 to 11, while the times 1 to 4, 6 to 9 and 11 to 12 were guessed to have less traffic. Also gates numbered 1, 9, 10 and 11 were judged to have heavier traffic than gates numbered 4, 8, and 12.

Two of us visited each of the gates, as workmen were busy putting the grounds in order, a week before the opening. Being caught up in the enthusiasm and optimism of the occasion, we decided that the heavily used gates could be split and the busy hours chopped and interviewers would be able, nay, they would be required, to interview <u>everybody</u> exiting.

Under this policy the sampling unit became a day-place-time unit, a DPT. At each of the hours 1 to 2, 2 to 3, 3 to 4, 6 to 7, etc. there was listed one DPT for each of the gates 4, 8, and 12 and two DPT's for each of the split-halves of gates 1, 9, 10 and 11. The A part of gate 1 was to be the lefthand two exits and the B-part was defined as the right-hand ones, and similarly for the other gates to be split. During the busy times, each hour was chopped into an early and a late portion. The early portion contained the first, the third and the fifth ten-minute period and the late portion was the remainder. To enumerate a selected DPT required interviewing <u>all</u> persons in parties whose first-exiting member crosses the exit line within the time assigned and leaving from the portion of the gate assigned.

3. SAMPLE DESIGN

The frame in its final form consisted of 1,452 DPT's divided into an afternoon (before 9) stratum of 957 DPT's and an evening stratum of 495 DPT's. The class was divided into 3 teams, each of 6 students [1]. Each team selected their DPT's using their own random number tables until the sample contained 4 afternoon and 2 evening DPT's. These selections were controlled in that all were on different days. Thus the original design was proportional stratified with controlled selection in 3 replicated subsamples. A very neat and promising design, or so we thought.

The fair began on Friday and field work done on that first weekend was a study in confusion. Too many people were exiting ever to begin to interview them all with the limited manpower of 2 persons at a gate. In addition, the questionnaire, even when self-administered, required that the interviewer work with only one party at a time. Consequently, when the class met on Monday, we had to redefine the measurement operation at a DPT. Then the data already collected had to be converted to the new basis. This adjustment was made rather than just throwing away the data on the first 3 days and redefining the population to consist of the last 6 days.

Assignment was made to a whole hour and to the whole gate (the former A and B divisions of the gate did not correspond to anywhere near equal volumes of traffic). The frame was left unchanged and thus the sample selection was not affected. Only the measurement operation was changed. Two enumerators were assigned to each DPT. They randomly selected a number from 1 to 10 to use as a start minute. After the start time they both counted persons exiting for 2 minutes (their watches were synchronized); then they interviewed the next two parties (one party for each enumerator) exiting after the count period. If a party or a person refused to be interviewed the enumerator marked questionnaires for such persons with an "R" and interviewed the

next party he could contact. The enumerators resumed counting after 8 minutes of interviewing and repeated this pattern of count-2-minutes-interview-8-minutes 6 times. Occasionally one enumerator would not finish his interviewing in time to resume counting but his partner was always there. The scheme was workable under the heaviest of traffic conditions and became worrisome only with sparse traffic. Then one could revert to interviewing every party [2].

There may have been some "edge effects" introduced because the counting always preceeded the interviewing of a DPT but they were minor indeed. The arbitrariness in phase of second hands of the enumerator's watches would seem to make the probability of a given party being interviewed by either the first or second enumerator roughly proportional to the time gap from the leader of two parties ahead to its leading member. It is reasonable to judge that the results were not biased in any practical degree by this introduction of slightly unequal selection probabilities.

4. IMPROVING SAMPLE DESIGN

The form of an estimated proportion was essentially:

$$(1) \qquad \hat{P} = \sum_{t=1}^{n} w_t \bar{y}_t$$

where w_t is a measure of traffic through the DPT based on the counting and $\bar{y}_t$ is the average proportion of the variable of interest based on interviewing. After accounting for the replication into 3 surveys, the stratification, and the controlled selection of the actual design, the expression for the variance of $\hat{P}$ was reduced to:

$$(2) \qquad V(\hat{P}) \doteq \sum_{t=1}^{n} [(\tfrac{1}{n})^2 V(\bar{y}_t) + P^2 V(w_t)].$$

The quantity $V(\bar{y}_t)$ becomes $\sigma_p^2 + \sigma_a^2/E + \sigma_g^2/EP + \sigma_e^2/EPI$ where E is the number of enumerators at a DPT, P is the number of parties interviewed by each enumerator at a DPT and I is the number of individuals interviewed in each party, while σ_p^2 is the DPT-to-DPT variance in the proportion and the other variance components correspond to their divisors. Because we did not re-interview people it was not possible to separate measurement error variance from true score variance and the definitions of the σ^2 are for infinite populations. Even more, we treated the 0,1 data as numerical for ANOVA computations, and just how unrealistic this is is not known. We formulated a cost function for interviewing as:

Cost in man-minutes = $10n + 100nE + 6nEP + 2nEPI$,

and were thus able to find an optimal allocation of effort. Only one person per party should be interviewed, more interviews should be made (lengthen the DPT in time?) but only one enumerator should be sent (we had sent 2).

Another derivation led to the expression for the variance of the counts as:

$$V(w_t) = (236n)^{-2}(30/r)^2 \times$$
$$\times [S_x^2(sr/30)^2 + rS_e^2(1 - r/30) + r\sigma_d^2/s],$$

where r is the number of 2-minute counting periods in a DPT and s is the number of enumerators making the counts. Here we did duplicate measurements so the measurement error can be separated. The component of measurement error variance σ_d^2 carries no fpc, while S_C^2, the sampling component does. One enumerator is found to be the optimal design in this case also.

When these recommendations are incorporated into an improved design it would appear that we could have reduced the variance by 28% for the same cost. Because of the very small sample sizes (3 teams) and the consequent uncertainty in estimating the variance components, one cannot take these results too seriously.

5. CONCLUSIONS

The usefulness of the study would seem to lie in:

1) Giving students experience in sample surveys.
2) Developing a workable sampling unit and measuring operation.
3) Verifying the usefulness of replication for detecting the importance of response error components of variance and to allow standard error calculations.
4) Illustrating the kinds of arguments needed for developing approximating formulas for complex designs.
5) Illustrating the kinds of computations that could be made with more data (and realistic data) to estimate the variance components.
6) Showing how a more elaborate design would be needed to estimate all variance components of interest [3].

[1] In each team one person served as chairman or communications hub, another selected the sample, one made field work assignments, another tabulated questionnaire responses, one calculated estimates and the last wrote the reports. This division of labor, as well as that into teams, was randomly made, of course.

[2] A strikingly similar survey situation and measurement operation is that described in P.V. Sukhatme, V.G. Panse and K.V.R. Shastry (1958), "Sampling techniques for estimating the catch of sea fish in India," Biometrics, 14, 78-96.

[3] These last four points were considered in detail in the original version of this paper, available from Dept. of Statistics, NCSU, Raleigh, N.C.