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ABSTRACT

Guidelines for basic sampling and weighting procedures for Massachusetts' Management and Information System for Occupational Education (MISOE) are discussed, illustrating solutions relevant for systems development. Disproportionate, stratified random sampling within and across MISOE subsystems will be carried out, with a hierarchical stratification over specified control dimensions. These dimensions will be: (1) sectors and subsectors, (2) educational programs, (3) regions where feasible, (4) locales and school types, and (5) students. As the second of two papers prepared to delineate MISOE's design, these planning considerations are detailed separately for the secondary school sector, the post-secondary programs, and various adult vocational education and manpower programs. Separate weighting procedures may be required for economic and noneconomic data, due to their distinct roles in MISOE. Although the multidimensional distribution of students demands stratification control, the program size limits the amount of control possible. Numerous recommendations are included, noting needs for further development of various aspects of MISOE. Cost effectiveness data are appended for followup purposes. Related documents are available as VT 018 602, VT 018 606, VT 018 809, and VT 018 810 in this issue. (AG)

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OCCASIONAL PAPER #10

SAMPLING AND WEIGHTING CONSIDERATIONS FOR MISOE

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Preface

This paper is one of a series prepared by the staff and a team of consultants to delineate and document the design of the Management and Information System for Occupational Education. It is the second of two such papers by the author, submitted as the formal response to staff inquiries, and as major tangible products of the consultation relationship. Gratitude is expresed to the staff for its extensive help in providing preliminary data and in conferences. The present paper discussed sampling and weighting issues and illustrates solutions relevant to system development. The staff is encouraged to make selective and flexible adaptation of the aids offered.

Occasional Paper #10 makes several references to Technical Memorandum #2, which is included in this publication as Appendix B.

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SAMPLING AND WEIGHTING CONSIDERATIONS FOR MISOE

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Part I. Sampling and Weighting Requirements for MISOE

MISOE requires collection of a high volume of data on a wide range of variables, over a hierarchically structured, varied, and geographically dispersed set of observation units. Under such circumstances it is neither logistically nor economically feasible to obtain all data on the complete set of observation units. Some data items can, indeed must, be obtained on such a census basis. Occasional Paper No. 1 defines this need in terms of:

1. providing a basis for selective trends data on enrollments, expenditures, and specific performance objectives, by program, locale, and school,
2. providing an annual description of same, and
3. establishing a population base for sampling.

The last implies the need for census information to control the sampling and to provide a basis for weighting sampling data to be representative of the populations of concern. The weighting procedures are required to adjust the sampling data for the sampling ratios in random sampling, and for any biases due to non-random sampling.

This paper presents the guidelines for basic sampling within and across MISOE subsystems, using disproportionate, stratified random sampling. By disproportionate is meant variable sampling ratios for the various cells of the sampling structure. Stratification will be hierarchical over specified control dimensions. Primary observation units will be programs; secondarily, students who are eligible for and/or actually flow through the system are also observation units so that sampling and weighting procedures must take this students-within-programs concept into account. Similarly, account must be taken of the way in which programs are distributed among schools and locales. Except for Boston, with about 15 schools, locales and schools will be treated on a one-to-one basis; only minor logistic adjustment should be required in a few other cities having 2-6 schools.

Illustrative sampling plans for the major sectors of occupational education will be offered in Parts II and III of this paper. These plans can only be regarded as tentative, to be modified by more complete information, when available, on the distribution of students among programs and locales. The missing information is unevenly distributed across regions (and possibly across programs), and in some cases is lacking from locales with high population densities. Every reasonable effort should be made to fulfill the staff expectations to complete this information in the census data system and to ascertain what adjustments in the sampling plans are to be made to ensure proper selection and representation of programs within each sector. Presently, available information does not indicate the school distribution <u>within</u> the city of Boston (035) and this may be required in some programs given in more than one school.

Special sampling considerations will be presented in Part IV for conducting followup surveys to obtain some of the post-impact information, for initiating the system on a cross-sectional basis, for dealing with cohort replacements, and for obtaining control groups. The weighting procedures required for estimating population parameters will be discussed in Part V, including those for control of bias in the longitudinal files due to nonresponse to followups.

If sampling and weighting procedures are properly handled in descriptive space as part of the data-entry system, no serious inferential problems should arise in high level descriptive or simulative analysis from this source. There are, however, certain limitations on the degree of control of sampling error and their effects in such a system and these will be discussed. Occasional

Paper No. 7 suggested how weights can be posted to data records and used in cumulating operations for estimating population parameters. Sampling variance in such estimates will be discussed; the need for this is stated on page 10 of Occasional Paper No. 1, which states a goal in terms of confidence limits.

Because there exists a great variation in program size and distribution of program offerings across sectors, school types, and locales, and because there are constraints on the costs and logistics of data collection, sampling and weighting considerations must take cognizance of the three-stage information collection process specified in Technical Memorandum #2, July 10, 1972.* Moreover, sampling and weighting procedures must be developed and implemented in a manner consistent with analysis requirements and considerations indicated in the previous occasional papers. It should be noted that the three stages of data collection are associated, respectively, with the Census Data System (CDS) and with the Sampling Data System in two parts, SDS (1) and SDS (2). The two parts of the SDS refer to data limited to input, cost, and impact for smaller programs in SDS (1) and full data, including those for process and product, for the larger programs in SDS (2). The data in the CDS are limited to costs, enrollments, completions, age, sex, and race. These are the variables which are available as bases for weighting sample data to population estimates.

The next section discusses stratification and standard errors to the point necessary to specify options available in small programs, and to suggest flexibility in setting the cutting point that separates which programs are assigned to SDS (1) and SDS (2).

*See Appendix B, pg. 63.

Stratification

The basic principle to ensure unbiased estimates of population parameters is randomization. This requires that each observations unit within a cell of the stratification design has an equal opportunity to appear in the sample. The sampling design will specify procedures for selecting schools and programs and it will be assumed that sufficient logistic control is available to prevent nonrandom losses of selected units. For a program within a school, it will be generally assumed that all students will be included in the sample except in a large school-program combination, where logistic arrangements must be made to ensure random sampling of the students therein. When data must be obtained from students, scheduling should be done in such a way as to avoid religious and ethnic holidays, football practice, or other special situations such that some proportion (more than 5%) of a special subgroup of students will be missing. Where this cannot be avoided, arrangements should be made for "makeup" data collection. Where some proportion of students within a large program given in a particular school are to be sampled, a selection by sections should be avoided if at all possible, unless there is good reason to believe that section assignments were random.

Stratification is introduced at the base of the sampling procedures for the following purposes:

1. tc ensure some random sampling within and over all sectors and subsystem spaces of MISOE concern;

2. to reduce the sampling error which would be obtained from simple random sampling over the entire system;

3. to allow disproportionate sampling to increase efficiency (using lower sampling ratios for homogeneous parts of the system; larger for heterogeneous parts or for ensuring adequate sampling of important but low base rate subgroups of observation units).

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The reduction in sampling errors in estimating population parameters (#2, above) is the classical reason given for stratification. Such reduction is a function of the correlation between the variables controlling the sampling design (dimensions of stratification) and the data to be obtained on the observation units. In large-scale programs this is a secondary consideration because no set of control variables is likely to be highly correlated across the highly diverse set of data variables involved. Moreover, purposes 1 and 3, above, are more critical for such general programs. The control dimensions are therefore chosen with these purposes in mind. The result is that some reduction in sampling errors from that observed under simple random sampling may be observed, but this will generally be small, especially as compared with the reduction in sampling error (as normally computed for infinite populations) due to sampling finite populations.

The control dimensions will be: (1) sectors and subsectors; (2) educational programs; (3) regions where feasible; (4) locales and school types; (5) students. In some cases, programs and where they are given may jointly define a stratification cell. There is too much variation in locales and enrollments among programs within program types, for the types to be a simplifying basis of stratification. It will, however, be convenient to discuss program sampling by their typological groupings (04, 07, 09, 14, 16, 17). Sampling considerations for each sector will be discussed separately in Parts II and III of this paper.

Classical sampling theory and its associated inferential statistics are essentially static in conceptualization, making no explicit reference to temporal changes in population parameters. In the absence of any dynamic sampling theory, longitudinal programs are forced to make certain conceptual and operating adjustments within the constraints of static inferential statistics. Actually classical theory does provide some flexibility in these matters, so that the problem is not critical, but requires staff awareness for proper formulation and interpretation of any significance tests. For example, it is both feasible and valid to make such tests as the following:

1. Given two samples of a population, the samples obtained at <u>different</u> times, set up the null hypothesis that the population parameters have <u>not</u> changed; if sample parameter differences are larger than expected under random sampling of a population without temporal change, reject the null hypothesis and conclude that a change has occurred in the population.. Use two-tailed tests.

2. Given the situation in #1, set up the assymetric null hypothesis that no change in population parameter has occurred in a <u>specified</u> direction, and accept or reject <u>this</u> hypothesis on the basis of a one-tailed test.

3. Given the situation in #2, set up the null hypothesis that a change of specified <u>amount</u> <u>and</u> <u>direction</u> has <u>not</u> occurred; use the one-tailed test with the hypothesised difference subtracted from the observed difference in the numerator for computing <u>t</u>.

Given a priori that some population changes are going to occur, in the longitudinal observation of a single cohort, or in the replacement of cohorts, practical suggestions can be made to keep the analytical base under some control for inferential error from sampling and weighting procedures. These are:

1. For a single cohort passing through a process channel, refer the results of student analysis back to the initial input situation;

2. When replacing a cohort at variable time points for different process channels, update the sampling and weighting parameters for that program so that analysis results will be representative of the population changes.

The first of these is rather straightforward; the second requires some further comment. In MISOE it will not be necessary to adjust the definition of the population every time a cohort replacement occurs. The practice of keeping track of changes in the population counts of schools and programs in the CDS permits periodic account to be taken of the fact that new schools and new programs are started, some become defunct, some may even merge, and there may be administrative shifts in the school-program joint arrangements. Such changes imply changes in the cell weights for new cohorts.

The important distinction between economic and noneconomic data and their roles in MISOE raises the question of whether separate sampling and weighting procedures are required. In the case of sampling, common procedures are necessary to ensure the match between economic and noneconomic data on a common base. Except for economic data expressed on a per student basis, separate weighting procedures, based on economic census data rather than on enrollments may be required. This topic will be discussed further in Part V. Sampling plans based on the distribution of students among higher dimensions of stratification should be checked for within-cell homogeneity of economic census data.

The major constraining problem for program-oriented sampling in MISOE is the multimodal, multi-skewed, multidimensional distribution of students across schools types and locales where programs are given, even when this is considered within the major sectors of occupational education. This demands stratification control, while program size limits the amount of control that is logistically feasible. This limitation is compounded by the fact that random sampling errors in descriptive statistics aggregated for programs, school types, or locales are inversely proportional to the square root of the number of observation units (students) on which the statistics are based. For example, the standard error of the correlation coefficient when the population parameter is actually zero is $1/\sqrt{N-1}$, so that even with 225 cases, the standard error is about .07, and sample correlations may fluctuate $\pm$ .14 (approximate 95% confidence limits). It takes about 1,000 cases to reduce the random sampling error to .03. The implication is that correlational analysis across IPPI elements as discussed in Occasional Paper #7 will be rather unstable. except in the larger programs and probably should not be attempted where less than 300 cases are available in the sample. (σ ca .58; $C.L._{95\%}$ ca $\pm$.12).

The standard error of the mean is a function of the standard deviation of the variable; however, reasonably stable means for continuous variables can usually be obtained with 30 cases. A categorical percentage, e.g., percent of students completing a phase or achieving a product standard of 50 (the parameter value where the sampling error is maximum) requires about 100 cases in the sample for the standard error to be even as small as 5% (i.e., 95% confidence limits would be about 40-60%). The standard error of a standard deviation is inversely proportional to $\sqrt{2N}$ and is therefore less sensitive to sampling variations than is the mean.

To be sure, the sampling errors for MISOE are reduced, markedly, by the fact that sampling is from a finite population (the reduction factor is $\sqrt{1 - N_s/N_p}$) and in the case of 100% sampling, reduces to zero. However, management decisions based on information from one cohort might be reasonably applied to later cohorts, so that there is a sense of sampling variance over time from a larger, less definite population. Technically, we are sampling from a population at a given point in time, but trying to generalize results to a population accumulated over a period of time. As MISOE obtains data on replacement cohorts, it will be possible to examine such temporal variations in sample data from programs which have not changed appreciably in input or process spaces.

The implications of these considerations for MISOE are that full analysis possibilities will be feasible only for larger programs and for suitably weighted aggregates across programs (e.g., when comparing OE and non-OE). Technical Memorandum #2 defines the larger programs for SDS (2) as "approximately

800 or more", and lists a few which are somewhat smaller. This paper considers sampling for programs within each sector so that a program manager has the option of analysis within sectors, which may differ considerably in locations, student types, costs, process details, and even objectives, or may consider program analysis over pooled sectors. This consideration and the fact that the sampling ratios can be varied, has led to consideration of sampling designs for programs within sectors. Combining this notion with the sampling error restriction leads to 300 students as an approximate cutting point on enrollment in a program within a sector for describing possible sampling and inclusion in SDS (2).* Note that this merely provides more flexibility at high costs and logistic effort, but does not require implementation. In a couple of programs with small but appreciable numbers in some sectors in addition to the major portion being in one of the sectors, it may be desirable to form one or more ad hoc cells to ensure representation of students in these sectors even though within sector analysis may not be possible. Thus, in the ensuing discussion, "small programs" are those with less than 300 students and within these programs, MISOE has the following options:

1. Obtain input-cost-impact data on 95-100% samples (SDS-I). Analysis within the small programs will be limited to gross entry level descriptive statistics, but can be aggregated with data from other programs for across-program analysis including correlational and simulational types. This option is indicated for programs in the enrollment range of 30-300 students.

2. Consider pooling cohorts to buildup more adequate samples in small, stable, but costly (or otherwise "important") programs. This option is relatively more attractive in the enrollment range of 100-250 and where the program length is short so that two cohorts will cumulate a sample close to 300 in reasonable time.

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*This does not take into account losses due to nonresponse to followup surveys. See epilogue to Part III., pp. 25-26.

3. Consider pooling two or more small programs within a general program type and which are highly similar. This option is not generally attractive because of the program orientation and interest in program variations in MISOE. Nevertheless, it should not be entirely ruled out where information about inputs, process, costs, and objectives indicate high similarity. Dichotomous variables indicating programs from which particular student records come can be included in regression analysis. Similar logic applies to dealing with the --9900, OTHER "programs" which may be a mixture of quite similar, but not identical small programs. Admittedly, this option is not attractive and its use presumes not only desperation, but further information about program homogeneity.

Another problem is that in those larger programs where sampling is feasible, the "same" program may have variations in inputs, processes, costs, and products at various locations where the program is given. The only way to ensure that all such variations are represented is to sample students within all locations within a program. This is not usually a logistically efficient procedure even where otherwise feasible. It should nevertheless be possible to ensure some representation of such variations in a program-oriented sampling procedure. Some will come into the sample by chance; alternatively, one can force them in, but this violates random sampling, unless an ad hoc cell is defined for them. With most of the programs, the size does not permit this without giving up some of the other stratification dimensions for that program. In the case of picking up special variations by chance, tagging such variations in the sample will provide some basis for studying their efficacy.

In some instances a program given at, say, 3 locations has 80% of the students at two locations and 20% at the third. Depending on the sampling ratio desired, one may wish to take two of the three locations and must pick them without randomization. Similarly, one may know of a particular program the sample data system. Such violation of pure randomness may be tolerated, if not too frequent; the price is additional uncertainty in the estimates of population parameters, weighting factors, and sampling errors.

It is likely that the initial sampling efforts during the development phase of MISOE will provide valuable experience concerning costs of staff efforts in sampling and data collection, and that such experience will be useful in modifying detailed sampling procedures for cohort replacements or deciding the feasibility of moving some medium size programs from SDS-II to SDS-III, or vice verse.

Part II considers the sampling issues for the Secondary School Sector of Occupational Education. Part III does likewise for the other sectors, except for the presecondary secto consisting of about 100 students in home economics. If this becomes of importance, the small program options, above, will be applicable.

No attempt will be made in the illustrative sampling plans to control on student types (e.g., sex, race. etc.); however, differential weighting options will be offered in Part V. Cell definitions and sampling suggestions will frequently refer to schools and school types, but it should be understood that this refers to the students within the schools sampled at 100% unless otherwise indicated.

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Part II. Sampling Considerations in the Secondary School Sector

The secondary school sector is the largest in terms of programs, school types, and variations in locales over the six regions, with very different numbers of students at the locales. The sampling will be discussed, illustratively, with comments for those programs having over 300 students in the secondary sector. It will be convenient to discuss these programs in groups by general program type. Programs with a large concentration in Boston will be given a special stratification cell without marked reduction in the sampling ratio to ensure representation of special racial-ethnic or other low base-rate groups concentrated in the metropolitan area.

<u>The Agricultural Group-01</u>: With the exception of Agricultural Production 010100, having 387, all agricultural programs are small. If the exception is admitted to SDS (2), take all secondary school cases in schools with at least 10 students and ignore the rest. If you desire to take a more modest sample for SDS (1) only, form two cells, one with about ½ of the Boston students and the other with all students in two of the schools. In SDS (1) you may want to sample 010500 Ornamental Horticulture taking the students from two of the schools (use 95-100% in the other small programs).

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The Distribution Group-04

The Apparel and Accessories program 040200 with 645 students can be sampled in one cell at 50%. If the present distribution holds up when the no information school data becomes available, the sample may be taken entirely from Boston, but it might be better to include all from school 262.

The Finance and Credit program 040400 has about 330 practically all in the Boston area. Take 85-100% for SDS (2) if desired, depending on the within-Boston school distribution of this program. For SDS (1), a smaller sampling ratio may be taken. The Food Service program 040700 with 141 students must be in SDS (1), but it may be noted that all but 14 are in three schools, which may be sampled 95-100%.

The General Merchandise program 040800 with about 1600 students is the largest in the group and provides opportunity for a well stratified sample of about 33% or 500 + students for analysis in SDS (2). Sample as follows:

Cell 1 - Boston - take 33-100% of students depending on the school distribution

Cell 2 - take all students in three of the 10 schools of Region I

Cell 3 - take two of the six schools in Region II

Cell 4 - take two of the five schoosl in Region III

Cell 5 - take one of the four schools in Region IV

Cell 6 - school 332 in Region V and school 236 in Region VI are in the population, take 332 at least with 236 optional. Sampling in this cell, may have to be modified when information becomes available for other schools in Regions V and VI.

The Insurance program 041300 with 349 students, all in Boston schools, may be included in SDS (2) with 80-100% sampling; for SDS (1) drop sampling ratio to about 50%.

The Health Group-07

Subjects in this program group are generally found in the post-secondary sectors, with only 425 indicated in the secondary sector, and 333 of these are in the 079900 Other category (see option 3, page 10, however).

The Home Economics Group-09

The large Comparative Homemaking program 090100 with 4300+ students can be sampled in the 1/10 to 1/8 range to yield a sample for SDS (2) of 400-500. Use 6 cells: Cell 1 -- take 2 of the 12 non-regular schools (400-885); Cells 2 through 5 -- take 1 regular high school from each of the Regions I-IV; Cell 6 -- take a school from Regions V and VI. Possible modifications are splitting Cell 6 if enough additional subjects are available when the NI schools have reported, and the addition of a cell for the 381 at Lowell. The latter will increase the sample considerably unless a random sample of students (about 100) were taken within this cell. Note, too, the special sex distribution in school 046, which could also form a special cell with random subsampling.

Care and Guidance of Children 090201 with 734 students can be sampled at about [illegible]% in 2 cells: Cell 1 -- take 3 of the 6 schools in Region I, and Cell 2 -- take 3 of the 7 schools in the other regions. Also select by toss of a coin either school 405 or 605 and add to Cell 2.

Food Management 090203 with 345 students, 200 of whom are at Lowell, can be sampled 100% for SDS (1) or SDS (2), or reduced a little for logistic convenience by placing Lowell in one cell with 100% sampling and taking half of the remaining schools in a second cell.

The Office Group-14

Most of the programs in this Group are large enough and concentrated enough in the secondary sector to permit extensive sampling for inclusion in SDS (2). In Accounting and Computing 140100 with 13K students, aim at about a

5-10% (650-1300 students) sample. Take one or two schools in a cell: Cells 1 — 6 for regular high schools in Regions I-IV, respectively, Cell 7 for Boston and Cell 8 for the Regional schools.

In Business Data Processing 140200, aim at about 1/10 sample of the 5K students. Use the same cell structure and sampling as in program 090100, except to add an ad hoc cell for Boston in which a logistically convenient sampling ratio may be used depending on the within-Boston school distribution for this program. About 100 subjects would be reasonable. Note that over-sampling in the Boston area is favorable for ensuring representation of low base-rate urban groups.

In Filing and Office Machines 140300 with 13K, sample as in 140100. It would appear that the same regular high schools could be used for these two program samples. However, you may wish to add a cell for the nonoverlapping schools, and will probably need to independently resample in cell 8.

Information Communications Occupations 140400 requires about a 1/5 to 1/4 sample of its 2000 students. Take about that fraction of students from Boston in cell 1 and take all students in about five of the other secondary schools giving this program.

Programs 140500 and 140600 are eligible for SDS (1); if you want to sample in 140600, take about half of the students in school 780 and all students in about half of the remaining schools.

The Stenography and Secretarial Occupations program 140700 with 10½K students can be sampled in accordance with the scheme for program 140300, except that an ad hoc cell for Lowell should be added and the 535 students there sampled (take about 100).

Program 140800, Supervisory and Administrative Management, though not included in the list in Technical Memorandum #2, has over 1600 students and probably should be sampled for inclusion in SDS (2). About a 1/4 sample may be obtained in three cells: Cell 1 -- take about 1/4 of those in Boston; Cell 2 -- take all of those in School 745; and Cell 3 -- take all those in about 1/4 of the remaining schools.

The largest program in the system is the Typing program 140900 with its 25K students permitting the most elaborate sampling plan, aiming at a 2-4% sample (500-1000 students) for SDS (2). The sampling should be accomplished in 11 cells, the first nine of which consist of regular high schools and the remaining two of which consist of regional high schools. These cells and their sampling are:

Cell 1 - take one school from, or a 1/3 sample within each school (better), at Lowell, Newburyport, and Peabody.

Cell 2 - take 20% at Malden

Cell 3 - take 20% at Worchester and at Natick regular high schools

Cell 4-9: take one or two regular high schools in each region

Cell 10 - take two of the 14 regional high schools in Regions II and IV

Cell 11 - take three of the 17 regional high schools in Regions III, V, and VI.

The Technical Group-16

Students in the technical group programs are concentrated in the post-secondary sector. There are only 358 indicated in the secondary sector with 160108 having the largest enrollment (130). Therefore these programs must be assigned to SDS (1) with 95-100% coverage.

The Trades and Industry Group-17

This moderately large group is very heterogeneous with many small programs which are obviously indicated for SDS (1). Several with sufficient size for SDS (2) are thinly spread over many schools and locales. Moreover, there is generally more spread across the sectors than in the case of the other groups of programs; therefore, we will take a special look at the cross-sector pooling possibility for the development of a special analysis sample for the manager of a program which appears to be too small for SDS (2) consideration within sectors.

The Air Conditioning program 170100 is a case in point. The 339 students totalled across secondary and adult sectors would permit SDS (2) analysis treatment if all data were obtained on all subjects and if they were appropriately tagged by sector so that dichotomous variables for sector membership could be generated and used in correlational analysis. Of the programs considered in the previous groups and assigned to SDS (1), only programs 040206 and 160108 would be candidates for this treatment. In Group 17, Blueprint reading 170500, Commercial Art 170700, Masonry 171004, Metallurgy 172400, and possibly Small Engine Repair 173100 are candidates in addition to the Air Conditioning program.

Returning to the secondary sector sampling of Group 17 programs, Body and Fender 170301 with about 750 students requires 1/2 sampling. Take all students in the five regular high schools in Cell 1, the two self-contained schools (406 and 760) in Cell 2, and four self-contained regional high schools (800 series) in Cell 3.

The somewhat larger Automechanics program 170302 with about 2,500 students is widely dispersed, so about a 1/5 sample in seven cells is indicated to cover the heterogeneity. The sampling suggested is:

Cell 1 - trade schools - pick either 405 or 406

Cell 2 - Region I schools regardless of type - pick two (exclude Boston)

Cell 3 - Region II schools regardless of type - pick two

Cell 4 - Region III schools - pick one

Cell 5 - Region IV schools pick two

Cell 6 - Regions V and VI - pick one school

Cell 7 - Boston - 25-50% of the students (310).

Essentially the same cell structure and selected schools may be used for Carpentry 171001 (N about 1,900), except that Cell 7 may be deleted. The somewhat smaller Electricity program 171002 (N about 1,400) requires a 1/4-1/3 sample in three cells: Cell 1 -- take four of the 16 regular high schools; Cell 2 -- take either trade school 405 or 406; and Cell 3 -- take three of the 11 self-contained vocational high schools.

Plumbing and Pipefitting 171007 has about 360 students making it a candidate for SDS (2) assignment if all or nearly all students are taken. If retained in SDS (1), take students in about half the schools.

The Drafting Occupations program 171300 with about 1,400 enrolled can be sampled at about 1/2-1/3 ratio in four cells:

Cell 1 - take four of 18 regular high schools

Cell 2 - take one of the three trade schools

Cell 3 - take one of the four regional high schools

Cell 4 - take three of the self-contained regional vocational schools.

Electrical Occupations 171400 with about 700 students in the secondary sector, with a 50% sample, should take one half of the Boston students in Cell 1 and the students in three of the six schools outside of Boston in Cell 2.

According to Technical Memorandum #2, Electronics Occupations 171500 may have two programs; these are not distinguished in the enrollment counts available to the author. A tentative sampling plan will be offered on the assumption that enrollments are concentrated in one of the programs, or that the sector divisions in the enrollment figures are clearly associated with the two programs. This, of course, must be checked, and if necessary, the sampling plan revised. The total secondary enrollment of about 1543 indicates a 1/4 sample, which can be obtained in three cells:

Cell 1 - take five of the 20 regular high schools;

Cell 2 - take one of the five self-contained regional schools

Cell 3 - take three of the 10 self-contained regional vocational schools.

The Graphic Arts program 171900 with about 1,250 students should have a 1/3 sample in three cells:

Cell 1 - take half of the Boston students

Cell 2 - take five of the 20 regular high schools, possibly the same schools as in cell 1 of 171400

Cell 3 - take three of the nine other schools.

The Metalworking Occupations 172300 have three program indications in Technical Memorandum #2 (Machine Shop, Sheet Metal, and Welding). These are not distinguished in the enrollment distributions available to the author. Despite the very large total enrollment for which 1/10 to 1/5 sampling appears indicated, a cell sturcture would be quite moot until more is known about these programs and their distribution. They are probably sufficiently different in content that they must be kept separate for both sampling and analysis purposes.

If Cosmetology 172602 with 336 students is to be included in SDS (2), take all subjects or take all at Lowell for one cell and take two of the remaining seven schools for the other. For SDS (1) take about half as many from Lowell and add one school.

Quantity Food Occupations 172900, if a single program with 616 secondary enrollment, can be sampled by taking all 127 in Boston in Cell 1, two of the six other regular high schools in Cell 2 and two of the six self-contained regional vocational high schools in cell 3.

It is not clear whether the enrollments available to the author for Woodworking Occupations 173600 are for a single program (Millwork and Cabinetmaking) or for a total involving more than one program. On the assumption that they are for a single program, the 1,450 secondary enrollment indicates a 1/4-1/3 sample for SDS (2) in four cells:

Cell 1 - take half or all of Boston

Cell 2 - take four of 20 regular high schools

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Cell 3 - take school 625 or 675

Cell 4 - take school 853 or 872.

This essentially completes the recommendations for secondary sector sampling. It should be noted that the Boys Vocational Extension program has 242 students all in Boston, and if homogeneous in content, may be considered for SDS (2). It is more likely to be in SDS (1) in any case, and definitely should be if heterogeneous. The Office, Other 149900 should be checked to see if subprograms may be associated with the high enrollment concentrations at Gardner and Pittsfield, which are high enough for them to be candidates for SDS (2).

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Part III. Sampling Considerations in the Other Sectors

The Postsecondary

The postsecondary programs for youths leaving or completing high school (this distinction might be an input characteristic) are for preparation to enter the labor market and are concentrated at the secondary schools (grade 13) of various types and at the 13 community colleges.

There are no candidates in program types 01, 04, 09, 16, 17, from the Postsecondary sector for inclusion in the SDS (2). Programs 040800, 070101, 090201, 160106, 160108, 160109, and 161113, have large enough enrollments that some sampling may be desired for SDS (1), probably 50-100% so that you have 100-200 subjects.

Sampling plans will be presented for two programs in the Health Group 07, and for four programs in the Office Group 14. The 625 students in the Nurse-Associate Degree program 070301 are in eight community colleges. Pick four of them for about a 50% sample. The 794 students in the Practical Nurse program 070302 can be sampled in three cells: Cell 1 -- take 50-100% of the Boston students; Cell 2 -- pick three of seven regular high schools; Cell 3 -- pick three of seven remaining schools.

In the Office Group-14: Accounting and Computing 140100 -- 600 students are found in eight community colleges. Take the students in four or five of the colleges.

Business Data Processing 140200 -- 600 students. Take those in four of the eight community colleges as one cell, and all in the self-contained regional vocational high schools in the second cell. Alternatively, the sample in the second cell may consist only of those in school 806.

Stenography and Secretarial Occupations 140700 -- take those in three or four of the eight community colleges.

Supervisory and Administrative Management 140800 -- take those in two

It may be logistically convenient to pick the community colleges which have these four programs in common with some violation of independent random sampling principles, assuming more or less homogeneity of student input and within-program processes across the community colleges. Note, too, that no information is available for some of the community colleges and the remaining colleges should be considered in the sampling.

The Adult Preparatory Sector

Adult Preparatory Programs provide part-time training to prepare for a new occupation. There are no candidates in program types 01, 04, 07, or 16 from the Adult Preparatory sector for inclusion in the SDS (2). Programs 140300, 171001, 171002, and 171500 have enrollments large enough that some sampling, probably in the 20-50% range, may be desired for SDS (1). This may also apply to the Other T & I 179900 with its 164 students concentrated in Boston.

Sampling plans will be presented for one program in Group 09, four programs in Group 14, and three programs in Group 17. Comparative Homemaking 090100 -- Form two cells; take half of those students in Pittsfield for one cell, and all those in schools 073 and 150 for the other.

Accounting and Computing 140100 -- 295 students are scattered across some 13 regular high schools. Either take all for SDS (2) or those in about half the schools for SDS (1).

Business Data Processing 140200 -- Take all or form two cells taking those in five of seven regular high schools and three of four self-contained regional vocational schools.

Stenography and Secretarial Occupations 140700 -- Take all of the 350 students in 10 regular high schools.

Typing Occupationa 140900 -- Take those in five of 15 regular high schools.

Automechanics 170303 -- Take all except in schools with less than 10.

Metalworking 172300 -- Counts show 493 students in 23 schools, but comments about three different programs, made for the Secondary sector apply here.

Quantity Food Occupations 172900 -- Take a 60-75% sample of the students in school 821.

The Adult Supplemental Sector

The Adult Supplementary sector consists of part-time training for those already in the labor market, but needing to update or upgrade their skills.

No supplemental programs in Groups 01, 04, 07, 09, or 16 are large enough for inclusion in the SDS (2). Programs 040800, 14900, 160605, 170100, and 171900 may require 50-75% sampling for SDS (1). All available subjects should be taken for SDS (2) in programs 140100, 140200, 140700, 140800, 170302, 171001, 171400, 171500, 171900, 172801, and 172902, if these are included in SDS (2). In some cases, a particular school will have less than 10 subjects and can be omitted. If it is decided that these programs within the Supplemental sector are to be assigned to SDS (1), despite sufficient numbers of subjects for some correlational analysis, they may be sampled at a 25% sampling ratio.

Sufficient numbers of subjects or special school distributions for more detailed sampling plans are found in programs 171002, 171007, and 172300:

Electricity 171002 -- Take three of six regular high schools for Cell 1; take all in school 405 for Cell 2; and take three of six schools in the "800" series for Cell 3.

Plumbing and Pipefitting 171007 -- Supplement the 200 in Boston (Cell 1) with those from half of the remaining schools (Cell 2).

Metalworking Occupations 172300 -- Although over 900 subjects are available, detailed sampling plans are deferred until the three program distributions are available.

The Apprentice Sector

The Apprentice sector provides adult classes for those workers in the trades and industrial occupations under an apprenticeship training agreement. In the Apprentice Sector, the Masonry program 171004 should be sampled about 1/4 for SDS (1); take 1/4 of those in Boston and two of the seven remaining schools. All available subjects, except those in schools with less than 10 should be taken for SDS (2) in programs 171002, 171500, 172400. Also for SDS (2):

Carpentry 171001 -- Take about 1/2, using two cells: regular high schools and schools in the "800" series.

Plumbing and Pipefitting 171007 -- Take about a 1/2 sample, using three cells:

Cell 1 - Boston

Cell 2 - "800" schools

Cell 3 - Remaining schools

Electrical Occupations 171400 -- Take about 3/4 of the students from Boston.

Metalworking 172300 -- Defer sampling until three programs distribution is obtained.

The Manpower Development Training Act Sector (PL87-415)

The special problem for sampling in the MDTA Sector is that approximately 3,500 students are distributed over some hundred program-locale combinations; of the approximately 40 programs, about 25 are given at single locations and 15 at 2-11 locations. With few exceptions, these programs must be 100% sampled and included in SDS (1). To the extent that these programs involve a special federal-state relationship and the allocation of funds and accountability problems may be of special concern, MISOE may need to consider a third sampling data system in which SDS (1) type of data is supplemented with some limited process-product information. MISOE may also wish to consider allowing some correlational analysis with higher sampling error risks, letting the program size cutoff within this sector drop to the 200-250 range (standard error of null correlations about .06). Programs given at single locations have 60 or less subjects and should be assigned to SDS (1) with 100% representation, as should those multiple location programs with 100 or less subjects. Programs with 100-250 subjects should be sampled in the 25-75% range for inclusion in SDS (1) or sampled 100% for inclusion in an SDS (3) if that option is chosen. For these smaller or borderline program decisions recall the small program options discussed earlier in this paper, especially the option of cohort pooling.

What is left for consideration are the few MDTA programs where inclusion in SDS (2) is a possibility either directly or after consideration of certain conditions and options. The first of these is the program labeled Prevocational. Assuming that this has some functional homogeneity and is not a group of small but very different programs, form either one or two cells from Boston, depending on the importance of distinguishing Project 1063 from 0117001; the former could be sampled at about a 1/3 ratio. One or two additional cells may be formed on a similar basis for the Springfield students with 100% sampling, and a cell added containing all students at the other four locations.

In the Nurses Aide program, take all available cases, except perhaps those in locations where there are only nine or 10 students. The Clerical Occupations program may be sampled in two cells: Cell 1 -- take 1/3 to 1/2 of the students in Boston and all of those at Fitchburg and Quincy.

The Licensed Practical Nurse program occurs at two levels with 175 regular students at diverse locations and 100 in an accelerated program given in Worchester. It is suggested that all available students be included with the accelerated students tagged for analytical purposes. The alternative is to leave this program in SDS (1) or SDS (3). A factor to be considered in such decisions is the possible importance of an allied health professional program.

Epilogue

The illustrative sampling plans presented in Part II for the Secondary sector and in the foregoing sections of Part III for the other sectors of occupational education are based on a cutting point of about 300 students enrolled in a program within a sector for deciding whether the program belongs in SDS (1) or SDS (2). This cutting point is based on a consideration of what is possible given the standard errors of correlational statistics within and between input, process, and product spaces, and the desire to provide for MISOE the maximum possible long-range flexibility for service to management. Immediate implementation of all of these plans is not necessarily indicated for initial development and implementation of MISOE as an operational system; they may be modified considerably, especially in those programs with sector enrollments in the 300-800 range. A major consideration in such modification is the fact that the response to followup surveys for impact data is certain to be less than 100% of those originally sampled, even with 100% attempt to contact. Connectability with impact data so obtained will be possible only for those who do respond to the followups (optimistically 80% in the one-year followup, 60% in the three-year followup, 40% in the five-year followup, and 30% in the 10-year followup). Whatever the response rate (and indeed the anticipated rate for a 10-year followup is so low as to indicate that this one be abandoned), allowance must be made in the original sampling to ensure that the analyses of longitudinal data will be not rendered meaningless by being mostly the result of sampling errors. To accomodate this, many of the programs with sector enrollments in the 300-800 range may have to be kept in SDS (1) with the understanding that correlational analysis of cost-impact data with input control will be impossible unless sampling ratios are increased.* For the remaining programs, increasing the sampling ratios will be helpful, but will generally require a greater logistic load on the staff because more schools will be involved, and will increase the total costs of obtaining and processing longitudinal data. Followups are expensive.

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*E.g., ignore the reduced sampling for SDS (1) described earlier for these programs and use the SDS (2) sampling recommendations even if the programs are assigned to SDS (1).

Part IV. Special Sampling Considerations

This part of Occasional Paper No. 12 discusses the sampling considerations related to initiating MISOE data systems on a cross-sectional basis, to replacing cohorts, to obtaining control group samples, and to obtaining followup data for longitudinal studies.

Initiating MISOE Data Systems

The first priority is to initiate the census data system obtaining complete enrollment, completor, and cost data, age, sex, and race input counts for all programs at all locations, in order to establish the full basis for sampling and weighting as well as the basis for management summary reports. Enrollment, input counts, and anticipated costs can be obtained for all ongoing cohorts, with actual costs and number of completors obtained as soon as possible on completion of each program. Using the latest available actual costs and numbers of completors from the latest cohort is not recommended because such actual costs are probably the basis for the present estimated costs and such completor counts are based on earlier enrollments. All pieces of the census data should be obtained for the same cohorts within programs to ensure connectability within the census data system and with the sample data systems. Anticipated and actual costs should be separately tagged. The data units in CDS are program-locale combinations by sectors. The data units in the sample data systems are individuals so that age, sex and race data must be included in the detailed input data by individual in the sample data systems.

Detailed input data are required in both SDS (1) and SDS (2) for both cross-sectional and longitudinal purposes. In the input space the same data could serve both purposes to simplify logistics and to reduce the lead time for obtaining data fully connectable across the IPPI elements. It is important that input data be obtained as soon as possible at the beginning of each program to avoid process contamination. For this reason, it is not recommended to obtain

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"input" data on a current cohort 1/3 to 1/2 way through a three-year program. It would be better to wait until a new cohort is available, even if this means delay in MISOE becoming fully operational with the longer programs. Time is sometimes a friend and sometimes an enemy.

The process descriptions and variables will be required for the programs in SDS (2). The observation units are programs within sectors with possible school-to-school variations. The student data records will contain process variables with the same values for all students going through a particular process. It is rather unlikely that the processes will change much from one cohort to the next, so that initially process data on currently ongoing programs may be obtained for the cross-sectional initiation of MISOE and most of it may be updated with change information for longitudinal purposes. On this assumption the process data should be generally connectable to input data in SDS (2) for both cross-sectional and longitudinal purposes.

In the product space, program completion-noncompletion for each sampled student should be available for both SDS (1) and SDS (2) on termination of current cohorts. For those behavioral objectives and phase completions which are a matter of program records or a matter of paper-and-pencil achievement testing, product information may be retrieved for current cohorts for cross-sectional purposes in SDS (2) and gradually supplemented as these programs are continued through their final phases. Product data which requires direct staff observation will be possible on current cohorts only for those phases and their objectives which have not already been missed, unless special observational sessions are set up for observing performances sometime after completion of the earlier phases. Once the longitudinal cohorts are set up and are being followed through, the timing and logistics of collecting product information can be more uniformly determined and applied as a function of within program process schedules.

Up to this point, there is reasonable connectability for cross-sectional data between input and process in SDS (2) and between process and product, but weak or uncertain connectability between input and product. There is also a great deal of extra staff and logistic effort to obtain the cross-sectional data some of which will either require time to mature or loss of connectability. The cross-sectional concept, presumably considered to advance the time by which MISOE might become at least partially operational, may not achieve this purpose, or do so at the expense of the analytic utility of the data. If only entry level analysis is contemplated with the cross-sectional data, thus not requiring connectability among IPPI elements, it may still be worthwhile, as Technical Memorandum #2 points out, for testing the system and providing considerable information.

Impact data obtained on a cross-sectional basis will not be connectable with anything, except with retroactively retrievable data in the other elements from cohorts which have already passed through the educational system. This is a plausible and useful thing to attempt for cohorts that completed programs in recent years, assuming that school records and supplementary sources will provide viable names and addresses, in addition to the cost data, and any other data that are to be connectible with impact in either SDS (1) or SDS (2). The main value of obtaining data in impact space prior to the maturation of a longitudinal cohort lies in the development of the logistics for followups and estimation of response rates. Both are somewhat dubious as indications of what may be encountered in the longitudinal followups.'

Because the utility of cross-sectional information is so limited and presumably temporary, and analysis largely confined to entry level descriptive statistics, smaller samples can be used than for the longitudinal data collection. Fewer cells, fewer schools and lower ratios of sampling of students within some program-locale-sector combinations would be involved with higher weights.

Because the same students may not be sampled for the various MISOE elements, separate weighting factors may have to be computed for each data type, to maintain some semblance of representativeness across the cross-sectional infusion of the two data systems.

Cohort Replacement

When a sector cohort has completed a program, it is to be replaced with the next cohort. Assuming that program schedules are approximately the same in one locale as in another, the replacement should pose no serious sampling and weighting problem. However, using the same cell structures and sampled locales, which should prove the simplest approach, the enrollments will likely change and, therefore, the weighting factors to be applied to the new cohort data will also change. To ensure continuous connectability between the census and sampling data systems, the census data should be continuously updated at cohort replacement time program-by-program within sectors. Note that the CDS carries more than the basis for "timely summary reports"; it is also the basis for weighting the samples to be representative of the current status of the system of occupational education.

Minor adjustments in the sampling may also be required if a program is given intermittently at some sampled locale. The locale should be replaced with another (at random) if available; otherwise, the weight adjustment will have to be relied upon to cope with the sampling change. Actually this might involve a bias, presumably small.

Any major shifts in the locales where a program is given or major changes in enrollment in a locale, by program expansion or contraction or by redistribution, will require adjustments in cell definition and possibly in sampling ratios within cells.

A number of comments have been made about cohort replacement in Occasional Paper No. 7 and in the sampling parts of this paper. These should be reviewed and integrated in MISOE development and planning.

Sampling for Control Groups

To be able to perform comparative analyses between occupational and non-occupational education, MISOE requires control group samples of students in academic and general programs in the Secondary and Post-secondary sectors. Input, impact, general educational development (pretest and posttest), and program cost data will be obtained for comparison with the same data types in occupational education. The appropriate sampling procedures depend upon the type of comparative analysis anticipated. The OE analysis of a given program may be compared with three different non-OE analysis types (six in the Secondary sector when the distinction between academic and general education is considered). One non-OE type of analysis for comparison is based on only those students in non-OE programs given in the same schools as those where a given OE program is offered. Another non-OE type of analysis for comparison is based on students attending schools in which OE programs of any kind are given. This would use a common sample for non-OE analysis for comparison with OE analysis for any program, but would base the comparison on a representative sample of only that part of the state's non-OE system. The third base would be a common sample for comparison with any OE program, but would be representative of the state's entire non-OE system for that sector.

These types of comparative bases correspond to somewhat different analytic hypotheses, and have different sampling and logistic implications. The first basis requires separate sampling for each program for which a comparison is to be made and would represent a very large effort to obtain a fussy refinement, which may not represent the real concern of management. The distinction between the first two and the third bases represents the fact that non-OE programs are given at schools with and without OE programs. The sampling considerations for non-OE will be discussed on the third basis, i.e., that a common comparative basis including students at schools without OE programs will be used to make analytical comparisons for each OE program analyzed. The non-OE analyses (one for academic in each sector, and one for general in the Secondary sector) should contain a dichotomous variable indicating whether the non-OE student was in a school where occupational education was also given.

In both the Secondary and Post-secondary sectors, enrollment counts on a census basis for non-OE students are required to obtain a basis for separate weighting of the non-OE data on the assumption that the students in academic and general programs are not distributed across schools in the same proportions as those in occupational programs, and to allow sampling of those non-OE students in schools without OE programs. The census counts should be obtained separately for those in academic and general programs. It may or may not be possible to use the same school level sampling for both.

MISOE may use a completely independent cell structure for the non-OE sampling, a structure based entirely on the non-OE census counts and school distribution. It may, however, be logistically convenient, and it would enhance the comparability to sample non-OE students from the same schools in the same cell structure as those used in the OE sampling, but to supplement with additional region-defined cells consisting of schools where occupational educational programs are not given. This supplement will not be necessary if the second of the three comparative bases, discussed above, is chosen. It should be noted that if the third basis is used, and later, it is decided that analysis on the second basis is desired, this will be possible but the reverse would not be the case.

Often in situations of this type smaller samples can be used for control groups. However, the sampling error constraints, including those implied by nonresponse to followup surveys to obtain impact data, indicate the choice of a sampling ratio such that 1000 academic students and another 1000 general students be included in the samples. Even this will be barely adequate, if at all, to allow for nonresponse to the longer range followups. It is likely that the sampling ratios within cells can be smaller to build up the common sample across schools, especially in cells where the non-OE students constitute a larger proportion.

In the Postsecondary sector, some of the occupational programs are given in the secondary schools as well as in the community colleges. Thus, the comparative basis should include some post-secondary students in secondary schools taking academic program, if such exist. If not, the comparison basis will be community college students in academic programs. In the Secondary sector, the comparative basis should include only secondary school students.

Detailed sampling plans cannot be offered at this time, but should be derived as soon as the necessary census data are available, and decisions are made regarding the bases for comparative analyses,* and on the issue of independent vs. matched cell structures.

Sampling Considerations for Followups

Although some of the impact data may be obtained from public records, most such data are expected to be obtained by contacting former students by mail with a survey questionnaire, at stated points in time following program completion. This will be required for those students included in SDS (2) and in the control groups, and at least for the larger sampled programs in SDS (1). Because of the anticipated problem with nonresponse to mailed questionnaires, all originally sampled students in programs for which detailed impact data are desired should be included in the mailout group. It is important to include dropouts and any transferring from one program to another.

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*Enrollment counts given in the Public School Directory are by sex of students, but not by occupational vs. academic vs. general programs.

It is important to obtain viable names and addresses from the students while "in the pipeline" and to update them on respondents to one followup for use on the next followup. Phone numbers may be helpful in following up hard core nonrespondents after sending out reminder postcards and using other techniques for reducing the nonresponse rates. Special additional weighting procedures will be required to adjust the longitudinal data for nonresponse bias.

The temptation to follow up random subsamples of the originally sampled students should be resisted. This procedure is indicated in programs with much larger input groups to reduce the followup costs. In MISOE, the reduced samples combined with the nonresponse problem will result in insufficient cases for stable analysis beyond the entry level. Therefore, the best strategy for MISOE is to followup all originally sampled students and use techniques to minimize nonresponse and the bias associated therewith.

Part V. Weighting Procedures

Data from samples in SDS (1) and SDS (2), including data from the control group samples must be weighted so that, in any aggregation and analysis, the population sampled or any defined subpopulation thereof will be reasonably represented. Weighted results of aggregation and analysis will then be relevant to the populations or subpopulations of interest to management. By computing and applying weights for each record at the student level, maximum flexibility and controls for bias are obtained. The initial set of weights correct for the varying sampling ratios among the various stratification cells for each program within each sector, and for any within-school random sampling. For noneconomic data, the weights are based on a comparison of the numbers of students (the ultimate sampling unit) included in the sample with the census totals. The options for economic data will be discussed in a later section. Weights are also required to control longitudinal data files for nonrandom losses due to nonresponse to followup surveys. The final weights to be applied to individual sample records in a given aggregation or analysis are products of the directly computed weights.

Occasional Paper No. 7 indicates how the weights may be posted to records and used in aggregation. The only additional problem on this point has to do with the non-integral nature of the weights and how the weights are to be placed on the files and used in analysis. This matter will be discussed in a later section on software considerations in weighting. Occasional Paper No. 7 also considers the analysis implications of legitimate losses of some kinds of process and product data due to dropouts; a special section of this part of the present paper discusses the options for weighting adjustment for such "dropout effects" in analysis.

Basic Input Weighting

The first type of weight to be computed and applied to all students records is the cell weight (Weight I). For any program within a sector, the weight must be computed separately for each cell. In any program within a sector, for which there is a single sampling instruction to "take all subjects", i.e., 100% sampling within a cell, Weight-I will, of course, be 1.00. Any program within a sector for which no explicit sampling structure has been indicated should be regarded as having a single cell which may or may not have been 100% sampled. To compute the type I weight, first cumulate the census enrollments for that cell across all schools included in the cell definition. Next cumulate the total enrollments in that program in those schools actually included in the sample. Weight I is obtained by dividing the former by the latter. Note that it is necessary to have the census counts which are not yet available to be sure of the cell structure and sampling ratios to be used, and to include these counts in the numerator for computing Weight I; otherwise, MISOE will not be dealing with the full population of students undergoing occupational education (or non-OE in the case of the control groups), but only that biased portion of the system that has readily responded with census data.

Some additional control will be obtained if Weight I is computed separately by sex and/or race of the students. In many programs, there is a strong predominance of one sex or the other. The minority sex should be included in the sample, but differential weighting is less critical than in the case where 25-75% of the students are of one sex.

If the differential option is not taken, there will be a weight of the first type for each cell within each program within each sector. This will be posted to the data records of all students sampled within the cell. If the sex differential option is taken, there will be twice as many weights in those programs for which the option is taken, but only that weight for males will be posted to records for male students and analogously for female students. Similar logic and operations are involved if a differential weighting option is chosen for a white-nonwhite control.

The second type of weight, which may also be computed differentially by sex and/or race, is the ratio of the number of students in a program (within sector) within a school to the number from that school with the same sector program included in the sample. In most cases, this will be 1.00, since all subjects are usually taken within a school. However, in the larger enrollment programs which are given in the large schools, some random sampling within schools was indicated and the Weight II will allow for this. Note that in the "Boston" cells, the distributions of students among and within schools is not yet specified so that sampling within Boston which is not 100% will imply non-unit weights of type I if a subset of schools is chosen; non-unit weights of type II if a sample of students within one or more large schools is taken. Weight II will be computed for each sampled school and posted to the data records for all sampled students from that school.

Weight III is the product of weights I and II by the appropriate sex and/or race of the student if the differential options are taken. It is uniquely computed for each student and posted to his data record. Weight III is unique for the student in terms of his sector, program, and school. Weight III will normally be applied to all aggregates of input data. It will either also be applied to data in other spaces or be a component of a product weight to be applied to other space aggregates and in interelement analyses.

The Dropout Problem and MISOE Options Thereon

The nonavailability of some process and product data for dropouts poses some special problems for MISOE both in aggregations and in analysis. Unfortunately, dropouts are not random losses and the problem is more severe in programs with high attrition and where, as is likely, the attrition occurs early in the program. The census data will include counts of completors but no indication of the process stage at which attrition occurs. This can be estimated by applying type III weights to dropouts in the samples, but not used as a basis for differential control of dropout bias in terms of points in time where losses occur.

Actually, the application of type III weights to data on dropouts only, or to that on completors only would not give unreasonable estimates in aggregation and analysis of the subpopulations of dropouts and completors, any more than would be the case for any other nonrandom subpopulation. The statements on page 46 of Occasional Paper No. 7 about analytical options with respect to these subgroups and their combination and on whether or not data are available still hold. MISOE has an alternative, refining option, and that is to recompute Weights I, II, and III (as IV, V, VI, respectively) differentially by dropout status with weight VI being applied to data. This would have to be done at program completion time when that status is known on a census basis and for all sampled students by program within sector and by stratification cells and schools. Alternatively, the differentiation can be confined to Weight IV as the recomputed Weight I (as differentiated or not by sex and/or race), eliminating the need for dropout status differentiation of Weight II and separate accounting for within school dropout variation. With this alternative, Weight I is adjusted to become Weight IV and Weight V is the adjusted Weight III, the product of Weights II and IV, to be applied to process and product data (input, too, in correlational analysis). This alternative is recommended if the refining option is taken at all, an option which is some additional trouble, but which introduces some partial control for dropout variations in the data across programs and locales.

Another alternative is an elaborate and expensive adjustment which adapts the logic and operations to be described below for controlling nonresponse bias in the longitudinal data including impact data from the followups. This possibility is not recommended at this time, but can be investigated more fully, if necessary.

Weighting of Cost Data

The importance of the economic data and their analytic role in MISOE require special attention to developing options for sampling, weighting, and integration of economic with noneconomic data in analysis. The discussion of such options makes the following assumptions:

1. Analogous to the enrollment distributions for the system, the census data system will include anticipated and actual total program costs for each program within each sector broken out by individual schools.

2. Derivative cost information will be available on the census basis from allocations of total costs to certain economically defined categories (capital costs, instructional, physical plant maintenance, etc.).

3. More detailed process costs will be available in SDS (2) for sampled programs within sectors by locales, and broken out by instructional phases (blocks, units, etc.) and program objectives.

4. The availability of enrollment data on a census basis permits conversion of any costs, or their allocations, to a per student basis when and if desired, within any breakout, in any data system.

5. Economic data such as family income (in input space) or earnings of graduates (in impact space) are obtained from and about individual subjects, and may be treated in sampling, weighting, and analysis in the same manner as other "student characteristics" data.

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Generally, from the standpoint of interconnectability of economic and noneconomic data, and for logistic convenience as well, sampling for economic data should follow the same sampling plan and actually use the same samples of schools within programs within sectors as that for the noneconomic data, as described in Parts II and III of this paper. In sampled schools, where less than 100% of the students are sampled and where conversion to a per student basis is made, divide costs by the total number enrolled in the program (or actually passing through a costed process phase of the program), not the number of students within a school actually sampled for that program. In the event that the census economic data (anticipated costs) show some especially high or low cost (per student) for a program given at some particular locale, MISOE may well want to ensure the inclusion of such a program-locale combination in the sample. It might be assumed that total costs are highly correlated with enrollments across schools in which they are given. This can and should be checked. If the correlation is low, MISOE may also want to ensure representation of program-locale combinations with extreme total costs. Moreover, some schools may have extreme patterns of allocation of their total costs. The census data should be inspected from this viewpoint to ascertain the need for modifying the sampling plan, probably by adding a cell here or there across the system; obtain both economic and noneconomic data in all cells, including added ones. Where adding cells is not possible, some trade-off between the cell structure recommended earlier and the modifications indicated by these considerations will be required.

Weighting recommendations must take into account the ways in which economic data at the program-school level and noneconomic data available at the student level are to be used in analysis. For entry level descriptive aggregation (and where such aggregates will be used in linear programming or dynamic simulation analysis), weighting of sampled process cost data may consist simply of the Type I cell weights, computed on the basis of the most similarly available cost data in the census system, instead of on the enrollment basis. In place of the options for computing differential weights by sex, race, or completion, the differentiation options here are the allocations, insofar as different kinds of sampled process costs are to be similarly allocated. Because of the uncertainties involved in the census allocations, MISOE may not find such differential weighting worth the effort, but it is as theoretically useful in control of sampling variations as the analogous options for the weighting of noneconomic data. Because the economic data are at the program level and the per student basis is computed from actual enrollments after applying the weight to the economic data, less than 100% sampling of students within schools is not relevant and therefore neither the Type II weight nor the Type III need be computed.

In computing the economic weight (it should have another type designation even though it is analogous to Type I), use the actual rather than the anticipated costs, even though there will be some delay involved in collecting the actual information. During the development and debugging phase of MISOE, however, weights may be computed using anticipated costs.

The weighted aggregates of economic and noneconomic data may be cross-tabulated, at the same aggregation level, with costs on total, allocated, or per student bases. It is rather unlikely that the economic and noneconomic data will be used in the same regression analysis. Should this be required using schools, programs, or other aggregates above the individual level as the unit of analysis, it should only be necessary to ensure that aggregates at the same analysis unit level are combined in the data record, whether total, allocated, or per student cost data are used. When the student is the unit of analysis, the per student cost computed from cell-weighted process costs (total or allocated) and actual enrollment may be posted to the student record along with the data on the process to which that student was exposed.

The entire student record will, of course, be weighted in terms of the enrollment-based Type III (or alternatives) weight discussed earlier. Note that this assumes that costs per student are constant for students taking the same program at the same school, an assumption that is being made anyway when computing and using per student figures.

The sampling and weighting considerations for economic data need to be carefully reviewed during the MISOE development period as more census information becomes available and as the analysis systems are developed.

Weighting for Nonresponse Bias in Followups

Following the collection of impact data through followup procedures, longitudinal files for analysis across elements can be developed using the respondents to the followup. That portion of the impact data obtained by mail and/or survey of former students, will, of course, be missing for nonrespondents, introducing a bias. The approach to developing final subject weights for such longitudinal respondent files is to form the product of a weight adjusting the file for the nonresponse bias and the Type III weight (or its alternative). The nonresponse-adjusting weight, Weight F, may itself be the product of some interim weights, and takes the respondent data back to representation of the followup group. If all originally sampled students are followed up, the Type III weight takes the followup group back to represent the original student cohort population. If only the completors are followed up, contrary to recommendations, Type II and Type III weights would require adjustment (note that dropouts constitute a relevant control group in impact space and should be followed up).

Separate followup weights, and therefore final respondent weights, would have to be computed for each followup at one, three, five, and possibly 10 years. Special adjustments will be required if only the respondents to one followup are included in attempts to contact on a later followup. Decisions about some of these logistic matters on later followups will depend, in part, on the response rates observed in the earlier ones.

The followup weight, and therefore the final subject weight, may be the product of interim weights designed to cope with differential response to multiple waves of intensive efforts to increase the response rate. Detailed recommendations for such elaborations of the followup weighting depend upon the details of followup logistics and the response rates for each wave. It is sometimes possible to treat the respondents to multiple waves as a single group for weighting purposes. To facilitate discussion of the development of the followup weight, it will be assumed that this is the case. Sporadic information is available about the cost of various mailout techniques; the results of one such study are presented in Appendix A of this paper. It should be noted that these are only mailout costs and do not include costs for processing data on respondents, or for developing the weights.

A typical logistic strategy is to follow the initial mailout, using first-class mail and live stamps, with a reminder postcard about a week later. Depending on the response rate to this first wave, a second wave mailout of the survey instrument may be made to the nonrespondents. A third wave using special delivery is sometimes useful. Experience with phone contacts of hard core nonrespondents indicates that this is a very expensive and not very productive technique. With a smaller group, possibly concentrated in a smaller region, it may be useful as a reminder device, but not for obtaining data. The Pentagon locator file may be helpful in ascertaining locations of those who have gone into military service.

Essentially two kinds of weighting procedures for adjusting data for nonresponse bias are available. One, the actuarial stratification method, is the classical one; the other is the inverse response probability method, developed in the Cooperative Institutional Research Program of the American Council on Education. The two methods will be described with their relative advantages and disadvantages. An empirical study comparing the ability of the two methods in reducing bias indicates the superiority of the second method.*

In the actuarial stratification procedure, sampling units are weighted in terms of variables purporting to measure and control for bias by defining a stratification based on those variables, and then computing weights based on the ratio of sampling units in the population in each cell to those in the sample. Variations in the method arise by differences in the choice of variables and levels, and their cross-tabulation or nesting in the stratification design. Once these decisions are made, the remaining weighting operations and bias estimation are usually straightforward. The method assumes within-cell homogeneity in the population and random sampling within cells. Such methods were recommended in Parts II and III for weighting for the original sampling.

Application of the stratification approach to the followup weighting requires a new post hoc stratification and involves:

1. Identification of variables related to the non-random bias resulting from differential probabilities of response to mailed questionnaires. This may be accomplished by capitalizing on input information and multicollinearity among variables using stepwise regression in prediction of nonresponse solely for identifying the key variables. Experience indicates that sex, race, ability, and aspirations are more frequently required control variables.

2. Ascertaining levels on these variables defining the stratification cell structure. This may be accomplished by examining cell counts resulting from various choices of cutting points on the variables and ensuring sufficient counts to provide stable weights with as many control levels as possible. Intuitive judgement is required to ascertain the final definition of the cell structure. By this method, all respondents within a cell receive the same weight and their data represent not only their responses, but also the presumed responses of nonrespondents who fall into the same cell.

*This study by Astin and Molm is as yet unpublished. The results will be

3. Computation of the cell weight as the number of subjects within the cell followed up divided by the number of respondents in that cell.

It should be noted that, whether this method or the inverse probability of response method is chosen, weights must be computed separately for each program within sector. Also, in both methods, the data for each respondent, when weighted, represent an estimation of the data for nonrespondents who are similar on the control variables. The regression analysis identifying these variables should use input data (student characteristics) and program completion status as predictors of the dichotomous criterion: subject responded or not. Product data may add to the prediction.

The other approach to weighting for the nonrandom nonresponse bias is one in which each respondent receives a weight based on the inverse probability of his being a respondent, given his profile on the control variables. The data from that respondent then represents not only his response, but also the presumed response of any nonrespondent with the same profile of input characteristics used as control variables. Stepwise regression is used not only to identify the control variables, but also to develop the equation for predicting the response probabilities. The variable-identification function of regression in both methods is especially useful where pretest information is available and the nonrandom sources of bias in the followup data are unknown. The advantages of the inverse-p approach to weighting include having variable weights for all subjects rather than constant weights for groups of subjects in a given stratification cell; moreover, no assumption is required about homogeneity and random sampling within cells. The disadvantage is the difficulty in providing formal estimates of bias and variance in parameters computed from the weighted distributions.

One further issue is that possible curvilinear and interaction effects beyond the main effects discussed so far may be involved. In the actuarial stratification approach, such effects appear, and are controlled for, by variations in weights among the cells, reflecting cell variations in response rates. Both the appearance and degree of control is only as fine as the cell structure permits. In the inverse-p procedure, it is necessary to hypothesize which variables may be involved in such effects and include generated vectors representing them in the regression system.

The adjusting weight for each respondent in the inverse probability method is essentially one divided by the predicted response probability. It is possible for an occasional predicted p-value to lie outside the range of 0-1. Such values are set by the program to the theoretical extremes to prevent weights being less than one. Normalizing adjustments and other refinements are available, some of which may not be feasible with the sizes of respondent samples anticipated in MISOE. One of the refinements is a ceiling placed on the weights, to protect against undetected errors.

Experience with the stepwise multiple regressions for predicting response shows, rather consistently, a leveling off at a multiple R of about .20, and rather consistently, a selection of sex, race, and some measure of ability and/or achievement as the key variables. The rather low multiple R could be the result of nonresponse being related to factors not measured in the input space, but this is rather unlikely given a large number and different kinds of measures available and allowed to enter freely into the regressions. More likely, much nonresponse can be considered as random effects once the demographic and ability factors have accounted for the nonrandom effects. It may turn out that weighting followup samples within programs within sectors has taken care of much of the nonresponse bias. Some simplifying options may become available in MISOE after some experience is obtained weighting the first followups.

Software Considerations in Weighting

Program GENWTS, available from the author, will be quite useful in developing the weights for the original sample and for weighting followup data by the actuarial method. Provision is offered for differential weighting for two subgroups, and the program can be readily modified to handle either more differentiations or the weighting of cost data.

The regression package, assumed to be available for general analysis purposes in MISOE, will be useful in identifying control variables for weighting followup data by either method. Software for implementing the inverse probability method for followup weighting can be made available, but will probably require some adaptation for applications in MISOE. Separate programs are required for computing the weights and for integrating them with the other weights for the final longitudinal analysis files.

Weights of all kinds are normally computed in floating point with care taken not to lose high order digits. Weights should be carried to two decimal places, multiplied by 100 and integerized for reading onto the analysis files. When the weights are read back into the computer for analysis using floating point, the F-conversion can be used to return the weights to their original form. In programs using integer conversion only (e.g., some cross-tabulation and head-counting programs) the integer form may be read in and final counts divided by 100.

Estimation of Parameters and Sampling Errors

Occasional Paper No. 7 (p. 18) presents the general basic equations for deriving aggregated counts, sums, sums of squared data elements and cross products, means, and elements of computing formulas for variances and covariances. These general formulas become specific as the indices of summation of student record data are specified to define an aggregate of analytical interest. With the weighting schemes suggested in this paper, the aggregates may cut across the stratification structures and apply to any grouping of individual records of interest. The parameters so estimated for the various populations and subpopulations in MISOE will not, in general, be unbiased, i.e., an average of estimates on replications of the system will not necessarily be exactly equal to the "true" population parameters. Moreover, if such replications were possible, the estimates would vary (sampling error). The recommendations given in this paper are designed to reduce the risks of both bias and variance, but it should be recognized that neither can be completely eliminated. It is sensible for MISOE to use census data wherever it is available in preference to weighted sample data.

It is very difficult, if indeed possible, to provide precise estimates of sampling fluctuations and of bias in estimated parameters in a system of this kind. In fact, no attempt will be made to do so, but the following comments will given some basis for making subjective estimates.

Classical formulas for computing sampling errors for simple random samples from an infinite population provide a very rough idea of maximum random sampling fluctuations. These are generally inversely related to the square root of the sample size, using the actual, not the weighted sample N's. Random sampling error, so computed, is reduced in two ways. First, sampling is from finite, rather than from infinite populations. The reduction factor in the sampling error for finite sampling amounts to $\sqrt{1 - N_s/N_p}$, and in MISOE will probably be a much more important source of reducing sampling errors than the second way, stratification.

The calculation of reduction in sampling error due to stratification is considerably more formidable and somewhat variable, depending on the type of estimator involved. The correction is a function of the among-cells variation about the estimator, which is related to the covariation between the variable (item), the distribution parameter of which is being estimated, and the variables defining the cell structure. In a general purpose sampling situation with many kinds of data involved and an a priori need to represent certain parts of the total system, as in MISOE, the stratification probably has small and variable effects on reduction of sampling errors. It does introduce some control by constraining sampling fluctuations against unlucky wild variations that could occur by chance under pure random sampling.

For the few items common between census and sample data systems (e.g., sex and race) obtained in the one case from school records as counts and in the other, from students completing input protocols, a comparison of weighted aggregate counts and proportions with those in the census will given some check on the weighting procedures and some idea of the overall efficacy of the sampling and weighting operations.

Bias in the estimators is a more serious matter in its influence in analysis and as a possible source of inferential errors. Biases tend to be in unknown directions and amounts. The recommended strategy is to use logistics of data collection which minimize bias and weighting procedures which identify and correct for detectable bias.

Part VI. Epilogue

This paper has discussed numerous sampling and weighting issues and options for MISOE with illustrative or suggestive recommendations. There remains considerable need for follow through during the development phase of MISOE to ensure sound choices among the options offered, more delineation of the integration of economic and noneconomic aspects of the system, finalization of sampling and followup logistics, and integration of these matters with the development of the data and analysis systems.

Appendix A

Appendix A

The tables in this appendix present "cost-effectiveness" data on various mail-out and followup techniques which were used in a fall 1971 followup of the 1966 cohort of freshmen in the ACE Cooperative Institutional Research Program.

There were approximately 60,000 former students in the 1966 mailout cohort. From the total group, 14 random samples of 1000 were chosen as "experimental" groups. Students without ZIP codes were then deleted from these groups resulting in slightly varying sample sizes.

Experimental "treatments" included in the following:

A. Outgoing Postage
   1. First-class live stamps (@16¢)
   2. Non-profit rate, printed permit (@1.7¢)
   3. Non-profit rate, pre-canceled stamps (@2¢)
   4. Non-profit rate, metered postage (@2¢)

B. Outgoing Envelope
   1. Window
   2. Non-window, requiring matched insertion of the questionnaire

C. Return Postage
   1. Live stamps (@16¢)
   2. Business reply (@18¢)

D. Postal Card Reminder
   1. Received
   2. Did not receive

E. Second Wave Questionnaire
   1. Received
   2. Did not receive

F. Personal Auto-Typed Letter Inserted with Second Wave Questionnaire
   1. Received
   2. Did not receive

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The assignment of treatments, the costs associated with those treatments, and the percentage of response to the various techniques are outlined in Part 1 of the enclosed tables. The first wave of questionnaires was sent during the first week of November; the reminder postal card was mailed four or five days later; and the second wave of questionnaires went to all non-respondents (whose initial questionnaires had not been returned as non-deliverable) during the last week of December.

Since approximately 15% of non-profit rate outgoing questionnaires were returned as non-deliverable (as compared to 8 or 9% of those sent out first-class), it was decided to remail questionnaires with first-class postage to those whose original questionnaires were sent out at the non-profit rate but were returned as non-deliverable. The "Part 2" table combines the Part 1 data with the non-deliverable remail outcomes.

One or two other analyses remain to be done (e.g., half of the second wave questionnaires were sent non-profit and half with first-class postage), but on the basis of the enclosed data, a followup of the 1968 cohort of freshmen which is going out later this summer will probably use the following approach: non-profit postage on first wave; window envelope; business reply return; a second wave questionnaire (with a printed form letter inserted) sent to non-respondents; a postal card reminder to second wave questionnaire non-respondents; and a first-class remail to non-delivered first wave questionnaires.

For the City University of New York project, we sent questionnaires (with non-profit postage and live stamp returns) in mid-September (1971) to a random sample of 2984 students who had enrolled (as freshmen) at one of 14 CUNY campuses in the fall of 1970. A week later, we sent all of them a reminder postal card and in mid-October a second wave of questionnaires went out to all non-respondents. A month later (November 12), a short-form (postal card) questionnaire was sent special delivery with a personalized auto-typed letter enclosed to 1560 non-respondents.

At the end of November, the names and fall 1970 home addresses of the 860 students who had not responded to either the full or postal card questionnaire were sent to a New York City survey research firm. The firm's interviewers attempted to reach by telephone each student or someone who could provide information about the student. For the final phase of the data collection process, we sent the names and addresses of a random sample of 100 students who had not returned a questionnaire and could not be reached on the telephone. Interviewers went to the students' fall 1970 addresses and attempted to talk with the student or a member of his family. The percentage of response to the various techniques is summarized below:

	Full Questionnaire	Postal Card Questionnaire	Telephone	Personal Interview	Total
Number Sent or in Group	2984	1560	860	100	2984
Number Received or Contacted	1522	343	608	43	2516
Percentage Response	51%	22%	71%	43%	84%

Although the response rate increased from 51% to 84% by application of the intensive followup techniques, the amount of information obtained from respondents to postcard questionnaires, telephone contacts, and personal interviews was markedly reduced, being confined to a few critical items, not connectable with other followup data available in the full questionnaire. This implies either a rather drastic application of the "missing data" options for analysis or a different set of weights to be applied when full data and partial data are to be analyzed. Such intensive followups can be useful in further characterizing non-respondents and possibly modifying weighting procedures.

The costs for these intensive followup procedures are rather high, as indicated by the following summary data:

1. Postal Card Questionnaire with Special Delivery, Auto-typed Letter Enclosed

   The postal card questionnaire was sent to 1560 non-respondents to the full-length questionnaire, for a total cost (postage, printing, auto-typing, etc.) of $2187.76. Three hundred and fourty-eight students returned the short-form questionnaires for a cost per response of $6.28. About 1/3-1/4 of the cost was for the auto-typed letter.

2. Telephone Interview

   A New York City survey research firm was given the names and fall 1970 home addresses of the 860 CUNY freshmen. They contacted 659 and obtained data over the telephone from 608 of those students at a cost of $4.75 per respondent.

3. Personal Interview

   The same survey research firm was given the names and fall 1970 home addresses of a random sample 100 "hard core" non-respondents. They obtained usable data from 45 of these students at a cost per respondent of $40. The sum was paid for locating about 85. On an actually interviewed basis, cost per respondent was about $25.

Percentage Response and Cost Per Response
For Various Followup Techniques
(1971 Followup of 1966 Cohort)

Followup Technique		# Mailed	Cost/Attempted Contact	# Returned	Cost/Response	% Response
First-class, window, business reply return						
eveloping & printing first-ave questionnaire -	$ 93.00					
nsertion in window envelopes -	24.75					
irst-class postage	156.96					
ostal card reminder*	53.57					
usiness reply return 330 (@ 18¢) -	59.40					
econd-wave questionnaire** -	183.98					
	$571.66	981	58¢	455	$1.25	46%
First-class, window, live stame return						
eveloping & printing first-ave questionnaire -	$ 93.00					
nsertion in window evelopes -	29.75					
irst-class postage -	156.64					
ostal card reminder -	53.57					
ve stamp return -	156.64					
econd-wave questionnaire -	183.98					
	$673.58	979	68¢	474	$1.42	48%

llowup Technique		# Mailed	Cost/Attempted Contact	# Returned	Cost/Response	% Response
First-class, matched insert, business reply return						
Developing & printing first-wave questionnaire -	$ 93.00					
Matched insertion -	39.75					
First-class postage -	156.96					
Postal card reminder -	53.57					
Business reply return (339 @ 18¢) -	61.02					
Second-wave questionnaire -	183.98					
	$588.28	981	59¢	464	$1.26	47%
First-class, matched insert, live stamp return						
Developing & printing first-wave questionnaire -	$ 93.00					
Matched insertion -	44.75					
First-class postage -	156.96					
Postal card reminder -	53.57					
Live stamp return -	156.96					
Second-wave questionnaire -	183.98					
	$689.22	979	70¢	466	$1.47	48%

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lowup Technique		# Mailed	Cost/Attempted Contact	# Returned	Cost/Response	% Response
Von-profit permit, window, ousiness reply return						
)eveloping & printing first-vave questionnaire -	$ 93.00					
nsertion in window envelopes -	22.75					
on-profit postage -	16.67					
ostal card reminder -	53.57					
usiness reply return 277 (@ 18¢) -	49.86					
econd-wave questionnaire -	183.98					
	$419.83	981	42¢	402	$1.04	41%
on-profit permit, window, irst-class return						
veloping & printing first-ive questionnaire -	$ 93.00					
sertion in window envelopes -	27.75					
n-profit postage -	16.46					
stal card reminder -	53.57					
ve stamp return -	154.88					
cond-wave questionnaire -	183.98					
	$529.64	968	54¢	411	$1.28	42%

llowup Technique		# Mailed	Cost/Attempted Contact	# Returned	Cost/Response	% Response
Non-profit permit, matched insert, business reply return						
Developing & printing first-wave questionnaire -	$ 93.00					
Matched insertion -	37.75					
Non-profit postage -	16.44					
Postal card reminder -	53.57					
Business reply return (280 @ 18¢) -	50.40					
Second-wave questionnaire -	183.98					
	$435.14	967	44¢	405	$1.07	42%
Non-profit permit, matched insert, live stamps return						
Developing & printing first-wave questionnaire -	$ 93.00					
Matched insertion -	42.75					
Non-profit postage -	16.51					
Postal card reminder -	53.57					
Live stamp return -	155.36					
Second-wave questionnaire -	183.98					
	$545.17	971	56¢	419	$1.30	43%

lowup Technique		# Mailed	Cost/Attempted Contact	# Returned	Cost/Response	% Response
Non-profit permit, matched insert, live stamps return, auto-type letter						
Developing & printing first-wave questionnaire -	$ 93.00					
Matched insertion -	42.75					
Non-profit postage -	16.73					
Postal card reminder -	53.57					
Live stamps return -	157.44					
Auto-type letter -	305.80					
Second-wave questionnaire -	183.98					
	$853.27	984	86¢	456	$1.87	46%
Non-profit permit, matched insert, live stamps return, no second-wave questionnaire						
Developing & printing first-wave questionnaire -	$ 93.00					
Matched insertion -	42.75					
Non-profit postage -	16.78					
Postal card reminder -	53.57					
Live stamp return -	157.92					
	$364.02	987	36¢	322	$1.13	33%

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lowup Technique		# Mailed	Cost/Attempted Contact	# Returned	Cost/Response	% Response
Non-profit permit, matched insert, live stamps return, no postal card, no second-wave questionnaire						
Developing & printing first-wave questionnaire -	$ 93.00					
Matched insertion -	42.75					
Non-profit postage -	16.78					
Live stamp return -	157.92					
	$310.45	987	31¢	282	$1.10	29%
Non-profit permit, matched insert, live stamps return, no postal card						
Developing & printing first-wave questionnaire -	$ 93.00					
Matched insertion -	42.75					
Non-profit postage -	16.54					
Live stamp return -	155.68					
Second-wave questionnaire -	183.98					
	$491.95	973	51¢	447	$1.10	46%

Followup Technique		# Mailed	Cost/Attempted Contact	# Returned	Cost/Response	% Response
13. Non-profit permit, (pre-canceled stamps), matched insert, live stamp return						
Developing & printing first-wave questionnaire -	$ 93.00					
Matched insertion -	44.75					
Non-profit postage -	19.46					
Postal card reminder -	53.57					
Live stamp return -	155.68					
Second-wave questionnaire -	183.98					
	$550.44	973	56¢	446	$1.23	46%
14. Non-profit permit, (meter), matched insert, live stamp return						
Developing & printing first-wave questionnaire -	$ 93.00					
Matched insertion -	42.25					
Non-profit postage -	19.66					
Postal card reminder -	53.57					
Live stamp return -	157.28					
Second-wave questionnaire -	183.98					
	$552.74	983	56¢	427	$1.29	43%

Cost of Postal Card Reminder

Printing -	$17.00
Addressing -	19.95
Postage	
978 @ 1.7¢ -	16.62
Total	$53.57

**Cost of Second-Wave Questionnaire

Printing -	$ 29.67
File update -	12.50
Matched insertion & addressing -	35.04
Printing of envelopes & letters -	31.17
Outgoing postage:	
300 @ 1.7¢-	5.10
300 @ 16¢-	48.00
Business reply postage:	
125 @ 18¢ -	22.50
Total	$183.98

Percentage Response and Cost Per Response
For Various Followup Techniques - Part 2

First-class Postage Outgoing			Non-profit Postage Outgoing Plus First-Class Postage to Non-deliverables		
Technique	% Response	Cost/Response	Technique	% Response	Cost/Response
Window, Business Reply Return	46.4%	$1.25	-	44.6%	$1.10
Window, Live Stamp Return	48.4	1.42	-	46.1	1.33
Matched Insert, Business Reply Return	47.3	1.26	-	46.0	1.14
Matched Insert, Live Stamp Return	47.6	1.47	-	47.2	1.34
			All the techniques below used matched insertion and live stamp return.		
			Auto-type Letter Included with Second Questionnaire	49.8	1.87
			No Postal Card	49.2	1.14
			Pre-canceled Stamps	49.2	1.27
			Metered Postage	46.8	1.33
			No Second Wave Questionnaire	35.4	1.19
			No Postal Card, No Second Wave Questionnaire	31.6	1.17

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Appendix B

Appendix B

July 10, 1972

To: Dr. John A. Creager

From: Dr. William G. Conroy, Jr.
Principal Investigator

Technical Memorandum #2

Subject: A Note on MISOE Sample

As a follow up to our Washington discussion, I felt it would be useful to communicate my conception of the MISOE sample.

Essentially, MISOE includes a 3-stage information collection process, with data connections across all three stages.

Stage 1. MISOE-CDS - For all 94 programs of Occupational Education a description of anticipated and real cost, enrollment and number of completors. MISOE-CDS includes an analysis system which "automatically" provides detailed and timely summary reports of MISOE-CDS data for appropriate management levels of occupational education. MISOE-CDS input data is restricted to age, sex and race.

Stage 2. MISOE-SDS(1) - For a representative sample from each of the 94 programs of occupational education in Massachusetts a detailed description of input and impact. This allows for cost/impact analysis by program, controlling for input types. It also allows for considerable comparative analysis among and across occupational education programs. Stage 2 input and impact data must be connectable to Stage 1 cost data by program for analysis. (It should be noted that Stage 1 and Stage 2 data constitutes entry level data for Stage 3 MISOE-SDS(2) data described below. The concept of entry level analysis was initiated in Occasional Paper #3 and might be referenced at this time).

Stage 3. MISOE-SDS(2) - For a representative sample of each of the occupational education programs with an enrollment of approximately 800 or more a detailed description of the product and process of these programs, including product-cost (by behavioral objective) information. General educational development data will also be obtained for Stage 3 programs. To establish connectability between total MISOE and occupational education practitioners during the initial development and implementation of MISOE, all LEAs offering programs classified in Stage 3 will be asked to report behavioral objectives to the State when they report anticipated enrollment and cost data.

It is helpful to note that total MISOE will be operational for all Stage 3 programs but not for programs excluded (because of limited enrollment) from Stage 3. For programs excluded from Stage 3, process-product data will not be available. Fundamentally, this means that the within occupational education manager will not be accommodated for non-Stage 3 occupational education programs.

Finally, for a representative sample of students enrolled in non-occupational educational programs at the secondary and post-secondary levels input, impact, general educational development and program cost data will be gathered. This allows for comparative analysis between occupational and non-occupational education described in our Occasional Papers. At the secondary level this includes students enrolled in general and academic programs, while at the post-secondary level it includes students pursuing academic programs.

MISOE samples will be drawn at the time of initial enrollment for each program and followed through to program completion and into impact space for all stages, i.e., MISOE is fundamentally a longitudinal data system. Cohorts are replaced upon program completion. During FY'73 MISOE-SDS(1)(2) will be identified and established for longitudinal study. At the same time a Stage 2 and 3 cross-sectional sample will be identified and formed for programs included in MISOE-SDS(2) and (3), and impact data will be gathered during FY'73 on a 1, 3, 5 and 10 year basis, thus forming a basis for initial analysis across all MISOE subsections. Cross-sectional data will be appropriately identified in both analysis and inputs. Such a cross-sectional consideration will allow the MISOE analysis system to be tested during FY'73, the last planning year, and provide a substantial amount of useful information.

The following is a tentative list of occupational educational programs to be included in the Stage 3 information collection process or MISOE-SDS(2). Please note that current information does not make clear the enrollment by program within the electrical, electronic and metalworking programs. The same is true for graphic arts and woodworking, but we consider these to be one program. I also believe electrical occupations describe one program, but this is not true for metalworking and electronics. Therefore, under electronics I am listing industrial electronics and communications and under metalworking I am listing separate programs entitled machine shop, sheet metal and welding.

Also included is a distribution of enrollment by occupational education programs and level.

SDS(2) OCCUPATIONAL EDUCATIONAL PROGRAMS

1. AGRICULTURE OCCUPATIONS

   There are no agricultural programs for Stage 3

2. DISTRIBUTION OCCUPATIONS

   a. Apparel and Accessories

   b. General Merchandise

3. HEALTH OCCUPATIONS

   a. Nurse - Associate Degree

   b. Practical Nursing

4. HOME ECONOMICS OCCUPATIONS

   a. Comparative Homemaking

   b. Care and Guidance of Children

5. OFFICE OCCUPATIONS

   a. Accounting and Computing

   b. Business Data Processing Systems

   c. Filing and Office Machines and General Office Clerical

   d. Information Communications Occupations

   e. Stenography and Secretarial Occupations

   f. Typing Occupations

6. TECHNICAL - There is not enough enrollment indicated in any of the technical programs for inclusion in Stage 3.

7. TRADES AND INDUSTRY

   a. Automotive Services

      (1) Body and Fender

      (2) Mechanics

   b. Construction and Maintenance Trades

      (1) Carpentry

      (2) Electricity

      (3) Plumbing and Pipefitting

ERIC

c. Drafting Occupations (Assumption: 1 Program)

d. Electrical Occupations (Assumption: 1 Program)

e. Electronic Occupations (Assumption: 2 Programs)

(1) Communications

(2) Industrial Electronics (Enrollment may be concentrated only on this program).

f. Graphic Arts Occupations (Assumption: 1 Program)

g. Metalworking Occupations (Assumption: 3 Programs)

(1) Machine Shop

(2) Sheet Metal

(3) Welding

h. Cosmetology

i. Metallurgy (Assumption: 1 Program)

j. Public Service Occupations

(1) Firemen Training

(2) Law Enforcement Training

k. Quantity Foods Occupations (Assumption: 1 Program)

l. Woodworking Occupations (Assumption: 1 Program)

(1) Millwork and Cabinetmaking

ENROLLMENT DISTRIBUTION

	%	Secondary	Post Secondary	Adult	Total
		78%	12%	10%	
Agriculture	1%	882	50	51	983
Distribution Occ.	3%	3,398	407	120	3,925
Health	3%	425	2,417	157	2,999
Home Economics	5%	4,979	1,037	136	6,152
Office	59%	61,383	5,874	1,539	68,796
Technical	2%	345	1,297	331	1,973
Trades and Industry	28%	19,551	3,709	9,183	32,443
	100%	90,963	14,791	11,517	117,271