MORE QUALITY FOR THE MONEY IN STATISTICS OF INCOME

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In general, it is difficult to determine the cost-effectiveness of techniques used to reduce non-sampling error in statistical processing. Attainment of optimum efficiency is usually hindered by inadequately defined quality goals for the intermediate processing phases and for the published data, insufficient integration of quality efforts in the various processing phases, and inadequate consideration of the state-of-the-art in quality control and processing techniques. Furthermore, the producers of Federal statistics (in contrast to a typical business) may not ordinarily aim for optimum efficiency due to lack of competition, absence of a profit motive, and difficulty of error recognition by the data user. Even if errors are recognized, they usually do not lead to such serious private industry problems as refunds, recalls, and legal suits. This paper gives the results of an analysis of the quality control system used in Statistics of Income (SOI) processing with the purpose of determining more effective utilization of the quality control dollar, if possible. It focuses on a number of proposed techniques that can help optimize the cost effectiveness of the system.

Organizationally, the paper is divided into several parts. The first of these provides a background of the Statistics of Income Division quality control program and items that have kept it from being optimally cost-effective. The remaining parts detail the various actions that have been, are being, and will be taken to remedy these deficiencies. These involve determination of quality requirements, developing procedures to meet the requirements, and incorporation of cost-effective measures in form design, instructions, training, preproduction, production, and post-production processing.

1. BACKGROUND

The Statistics of Income Division of the Internal Revenue Service has utilized various techniques to control, improve, and/or measure the quality of the data it publishes. These have consisted of preproduction, early production, regular production and post-production actions in one or more of the processing phases. The processing phases generally involve editing (abstraction) of information from tax or information returns onto edit sheets, transcription, consistency testing, error resolution and table production. The processing takes place at one or more of eleven IRS processing centers (ten service centers and the Data Center at Detroit). All actions were intended to control, measure, and/or improve the quality of the data, and in most cases, if not in all, the intent was probably achieved.

However, a quality control program cannot be considered optimally effective merely because it attempts to and perhaps actually controls or improves the quality of the processing. For a quality control system to be optimally effective, it must involve all areas of the program from inception to completion, and it must be incorporated so as to produce the desired quality with the least expenditure in resources. The first of these aspects has been fully covered [1] and was given additional emphasis following a recent reorganization of the Division. [2] The second aspect has not been given sufficient consideration and is the subject of this paper. The cost effectiveness of the quality control program can be optimized or at least significantly increased by taking steps to remedy the following deficiencies:

1. Insufficient specific information provided by the data user on the quality needs.
2. Insufficient use of historical data to determine the effectiveness of past efforts and pinpointing problem areas for localized quality control application.
3. Inadequate use of tolerances for errors.
4. Definition of a defect or a defective document without adequate consideration of the significance of the item or the complexity of the document.
5. Absence of or arbitrary quality levels set for the data at the intermediate and final processing phases.
6. Insufficient effort to reduce the likelihood of error by simplifying forms and instructions.
7. Insufficient effort to reduce processing errors by simplifying and documenting training.
8. Insufficient preproduction effort in some of the processing phases.
9. Lack of integration of the quality efforts in the various processing phases.
10. Implementation of various quality control techniques without sufficient indication of what they would accomplish or without requirements for follow-up analysis of their effectiveness.
11. Insufficient consideration of the impact that changes to the processing operations could have on the quality of the data.
12. Absence of information on errors in the completed product.

Remedies to the above deficiencies, if not already considered in the 1980 SOI processing

operation, are being incorporated into the 1981 and subsequent SOI programs with the intent of attaining the desired quality with the least expenditure in resources.

2. QUALITY CONSIDERATIONS IN THE MEETINGS WITH THE DATA USERS

Quality Needs of the Data User.--The most important factor in the SOI operation, as it is in any production or processing operation, is determining what quality level should be strived for. To determine this, one needs to know who will use the product, how they will use it, and what effect different quality levels would have on the efficacy of its use. Generally the user is not sufficiently familiar with the costs, benefits and limitations of quality control to be able to provide specific requirements for which a cost-effective system can be developed. Such vague requirements as "We want reliable data" or "We want as few errors as possible" are not sufficient and often result in various arbitrary quality applications. In this type of situation, it is incumbent on the data producer to inform the user of the cost-benefit relationships of various quality measures. This can cover the range from near-zero costs for quality control, where quality levels produced with little or no review are acceptable, to the costs involved when near-perfection is desired. In SOI, sufficient historical data exist for most of the processing operations to provide these data. In discussions with the data user, acceptable quality levels for the various intermediate processing phases and for the end product can be determined.

Figure 1 shows the current quality levels achieved in selected SOI programs prior to any quality control application.

Figure 1.--Editing Error Rates for Selected SOI Programs

SOI Program	Number of Documents Edited	Percent of Documents in Error
1040 Nonbusiness	103,276	20.5
Business	75,254	32.6
Farm	7,812	32.2
1120 Regular	54,209	19.3
"Giant" [3]	1,904	45.1
1065	51,236	5.5

Data such as the above are being used to help determine quality requirements. What kind of quality measures to take and in which areas will depend on how much the quality has to be improved, if at all, in order to meet the requirements. Only the needed amount of quality control should be applied, not more and not less. This will change various approaches taken over the years in SOI in a number of areas.

3. FACTORS TO BE CONSIDERED IN THE DEVELOPMENT OF QUALITY CONTROL PROCEDURES

Use of Historical Data.-- In most processing operations there are data available from previous quality control procedures that can serve as invaluable tools for optimizing subsequent quality control systems. In SOI, such data are available for many years and cover most if not all phases of the data processing operation. Historical data can indicate what the normal expected quality is in a certain function (such as data abstraction or transcription) and therefore what if anything needs to be done in terms of quality control. The data show in what areas errors are most likely to be made, how significant the errors are and how they are affected by various quality control measures. Consequently, these data can be used to pinpoint the areas that should be covered, the extent of coverage and even the type of coverage so as to produce the most efficient operation. A certain error, for example, could be eliminated by changing the instructions and/or training. Some errors, those of acceptably low frequency, could be "tolerated." Some errors may be good candidates for consistency test coverage (computer checks) and thus may be omitted in previous processing operations quality control measures. By analyzing historical error data in all phases of SOI processing, unnecessary quality assurance review can be weeded out and the most efficient quality control procedures can be applied in areas where they are necessary. Figure 2 shows historical editing error rates for selected items in selected programs.

Figure 2.--SOI Editing Error Rates for Selected Items

Edit Sheet Item	SOI Program	Percent of Items in Error
Adjusted Gross Income	1040	0.0
Total Depreciable Property	1040	1.0
Interest on U.S. Obligations	1120	0.0
Employee Benefit Programs	1120	3.6
Repairs	1065	0.0
Ordinary Income/Loss	1065	5.7

Adequate Consideration of Tolerances.-- Assignment of error tolerances can have a very significant impact on quality and on resources expended in processing. Tolerances beyond those normally achievable in the state-of-the-art processing guarantee either a high error rate or a large expenditure in resources to reduce it. SOI utilizes tolerances in the editing of the various programs, but in setting tolerances the state-of-the-art processing capabilities and the effect of various degrees

of error on data reliability have not been adequately considered. Tolerances range from zero to several thousand dollars, determined often on an arbitrary basis by the project manager. A tolerance, in order to be cost-effective, should be as loose as possible and still achieve the required reliability. We are currently reviewing the various tolerances in the editing and other processing instructions and will try to bring them more in line with what is possible and what is required.

Definition of Defect and Defective.--Quality control procedures and costs can vary significantly based on how one approaches the definition of error in the processing. In SOI processing, a document is generally considered to be the unit of production and consequently the unit of error and of quality application and measurement. This approach fails to adequately consider the complexity of the document. Some documents have 50 entries; some have 150. Normally, the document with 150 entries would be expected to and should generally be allowed to have three times as many errors as the document with 50 entries, without being considered any less accurate. If one defective entry in each document constitutes a defective document and the percent defective document value is used to develop quality control procedures, more extensive quality resources will be expended on complex documents, making the quality in complex documents unnecessarily better than in the simpler documents.

A more appropriate unit of error may be the entries on the edit sheet. As an example, prior to any type of verification procedure, about 25 percent of the edit sheets in the 1040 SOI program have one or more errors. Yet, less than one half of one percent of the entries are in error. If quality goals were based on the percent of entries defective, less costly quality control procedures could be incorporated.

Missing or Arbitrary Quality Control Applications.--In the past there has been no overall plan when quality control procedures were prepared for SOI projects. Some programs such as the 1040's and 1120's received rather heavy emphasis; some like the foreign income studies were virtually ignored. Although limited resources required some arbitrary decisions on how to apply them, they were not always made with adequate consideration of cost-benefit ramifications. Historical quality levels were not adequately considered in determining the quality control emphasis. Specifically, 1040A's which are relatively simple forms, rarely subject to serious errors, and readily corrected in consistency testing, received fairly extensive attention. Currently, efforts are being made to eliminate or at least reduce the "overkill" measures and apply needed measures in the neglected areas. Shooting for perfection in some areas, such as for large corporation returns, and virtually ignoring others appears inefficient when in fact there have been no specific quality requirements for any of the programs. Figure 3 shows edit verification plans for selected programs along with resources expended and results achieved.

Figure 3.--SOI Edit Verification Activity and Results Achieved (1979 SOI Programs)

SOI Program	Percent of Documents Verified	Percent of of Documents Defective After Verification
1040	29.8	5.7
1120 Regular	47.3	10.3
1120 "Giant"	100.0	16.8
1065	14.9	21.5

4. QUALITY CONTROL IN FORM DESIGN, INSTRUCTIONS, AND TRAINING

Error Prevention Through Form and Instruction Simplification.--The degree of quality control required during processing depends to some extent on the type of forms and instructions. Simple and clear forms and instructions can sometimes lead to sufficiently adequate quality so that subsequent quality measures could be all but eliminated. The comprehensibility of the instructions also determines the necessity and degree of training. Clear forms can sometimes make training unnecessary. It is interesting to note that IRS holds no training sessions for the taxpayer, relying on the clarity of the instructions to enable the taxpayer to satisfactorily complete the tax return. Granted, taxpayers make errors, probably because the instructions are perhaps not as clear as hoped.

In SOI, error rates are generally higher for items with complex instructions than for items with simple instructions. In fact, the degree of error can sometimes be predicted by considering the complexity of the instructions for processing the item. An item for which the source is identified on the edit sheet in terms of a line item on a tax return generally has the lowest error rate, whereas an item with lengthy instructions that require the editor to include or exclude specified information and require calculations or cumputations generally has a high error rate. Recognizing the effect of instructions on processing accuracy, attempts are being made to simplify them whenever possible. Figure 4 indicates the effect of instruction complexity on processing error rates for selected items.

Error Prevention Through Effective Training.--Although training is sometimes not necessary (if the form and/or instructions are sufficiently adequate), the accuracy of some complex items may be increased by selective and effective training. In SOI, substantial resources are expended on training. This has been done year after year with perhaps insuf-

Figure 4.--Effect of Instruction Complexity on SOI Editing Quality (1979 SOI Programs)

SOI Program	Item	Complexity of Instructions			Percent Of Items Defective
		Simple	Moderately Complex	Complex	
1040	State Income Tax Refund	X			0.0
	Travel & Entertainment Expenses		X		1.5
	Total Depreciable Property			X	5.0
1065	Interest Income	X			0.0
	Other Income		X		3.0
	Total Cost of Depreciable Property			X	9.0

ficient consideration as to its effectiveness. In order for training to be cost-effective, it should not repeat, replace, modify, or contradict instructions. Training should highlight and explain possible difficult or complex instructions and should include a work session which will help uncover previously unrecognized difficulties in the instructions. In SOI training, some trainees write down what they perceive the training instructions to be. Some neglect to record them altogether.

Numerous instances occur in SOI processing where errors could be traced directly to a training instruction that conflicted with written instructions through deletion, addition, modification, or correction. Since training is not 100 percent documented and provided to all processing personnel, many variations of implementation are possible and have in fact occurred. In order to avoid this problem, training techniques and procedures are being reviewed to eliminate unnecessary and ineffective measures and to ensure that if they are different from the written instructions they are fully documented and disseminated to all processing personnel. This may involve written, audio, and/or video documentation. In addition, all trainees have been requested to provide a copy of their notated instructions to the project manager so that it can be determined if they correctly understand them.

5. QUALITY CONTROL PRIOR TO THE PROCESSING OPERATION

Preproduction Efforts.--One of the principal contributors to inefficient processing is lack of preparation. Going into full production processing without some type of preproduction (test) processing can be catastrophic and often results in unexpected error situations which add costs to the processing, delays, and sometimes even produce worthless results in terms of quality. A preproduction effort can help determine what degree of quality can be produced with the tools currently available. Although such efforts should always be considered in a new program, it is also advisable to include them in a repeat program when there have been significant changes in the program items, processing instructions, equipment, training, or personnel. If the preproduction results are acceptable, very little may have to be done in terms of quality control in the actual processing. If weak areas surface, quality control efforts can be applied in these areas specifically while de-emphasizing other areas.

A preproduction effort for the editing phase was instituted in the 1980 1040 SOI program. The resulting data were extremely useful in indicating what errors were being made, who was making them and even why they were being made. Through quick feedback of these data to the originating processing locations, timely remedial action was effected. Although the data were not used to modify existing quality control procedures in the editing phase, the errors were analyzed to determine if they could be successfully treated in consistency testing. Figure 5 indicates the source of preproduction errors and their frequency.

Figure 5.--SOI Editing Preproduction Error Source and Frequency (1980 1040 SOI Program)

Source of Error	Error Percentage of:	
	Total Errors	Editor Errors
Editor	90	
Omissions		42
Incorrect Entries		37
Transpositions		8
Erroneous Copying		7
Others		6
Instructions	5	
Training	3	
Illegible or Missing Data	2	

6. QUALITY CONTROL DURING THE PROCESSING OPERATION

Integration of Quality Control Efforts.--Until recently, SOI quality techniques have consisted of 100 percent review of a sample of edited documents, 100 percent review of transcription, SAT (Systems Acceptability

Testing) of processes involving computer programming, no manual review of error resolution changes and 100 percent review of data tabulations. Except for the editing review, the source document has generally not been utilized in the review. By considering the quality requirements and cost-effectiveness of the quality techniques in the various processing phases, significant cost-saving changes can be made in many areas. For example, in a relatively simple program segment such as 1040A's, verification at both the editing and transcription levels can probably be eliminated and quality needs can be covered through consistency checks. On the other hand, for very complex program segments such as large corporation returns, the crux of the quality efforts will probably continue to be applied in the editing phase, but perhaps not for each and every document item as is currently being done.

Quality control procedures should never be incorporated just for the sake of having quality control. They must serve a purpose and that purpose must be spelled out. It should be known from the outset what the quality control procedures are intended to accomplish. An arbitrary application of 100 percent review in a certain processing phase just to find errors and correct them if they are there does not meet this purpose. If the errors are unlikely, 100 percent review is not an efficient quality control measure. Too little is gained from a sometimes sizeable investment.

Untested Quality Applications and Lack of Follow-up Analysis.--The application of new quality control procedures without information on what they will produce is generally not cost-effective. They must first be tested. If they are nonproductive, the resources lost will be kept to a minimum. If some procedures are ineffective they should be dropped. Often there is no follow-up analysis to determine if in fact certain procedures or changes to procedures produce worthwhile results. They should not be instituted if their cost benefit cannot be first demonstrated and subsequently supported. Some SOI quality control measures have been implemented and continued without properly addressing these two elements. Such items as submission of a New Item sample in the 1040 program, an Early Production sample, requirements for 100 percent verification in some processing functions may or may not be cost-effective. The resulting data have not been sufficiently analyzed to make a determination. This is currently being done, with a view towards optimizing the resources expended.

Awareness of and Reaction to Changes in the Processing Operation.--Sometimes quality control efforts do not achieve their desired results because certain assumed processing conditions undergo changes. For example, there may be a new supervisor, new employees, or changes to the instructions or the processing equipment. A quality control system installed to optimally cover a certain assumed processing situation may no longer be optimum when significant changes occur. Processing center statisticians (whose function, among others, is to monitor the SOI processing) will be encouraged to remain constantly alert for any such changes and inform the project manager so that timely action can be taken to modify the quality control procedures. In conjunction with this, greater use of error reporting will be made in terms of modifying quality control measures when it appears that the processing quality has improved or deteriorated from the originally assumed levels.

7. QUALITY CONTROL AFTER THE PROCESSING OPERATION

Determination of the Data Reliability in the Tabulations or Report.--In the past, periodic attempts were made to measure the quality of the SOI data in the completed computer file; in other words, the quality of the data from which the published tables are derived. Resource constraints, however, caused the abandonment of many of these efforts. We are now taking another look at this area because these kinds of data should always be part of the data provided to the user. Reliability of the computer file can be determined in two ways: sampling the documents in the file and determining the quality of the data, or calculating the quality of the file by considering the quality control or quality measurement data from the various processing phases. However, since we currently do not have adequate quality applications in all processing phases, it is more practical to utilize the first means.

The Quality Measurement sample (currently used to determine the quality of the SOI editing) can readily be utilized to measure the quality of the computer file. At the same time, it can provide valuable information on error introduction (or resolution) at the various processing phases such as in the editing, transcription, and consistency testing. This type of information will enable us to much more efficiently direct the quality control efforts to where we get the biggest return for the dollar invested.

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NOTES AND REFERENCES

[1] Durkin, Thomas M. and Schwartz, Otto. "The SOI Quality Control Program." 1981 American Statistical Association Proceedings, Section on Survey Research Methods.

[2] As part of the reorganization of functions in the Statistics of Income Division, the Quality Control Section, which had quality control responsibility for specified areas of SOI processing, was abolished. The quality control responsibility (now involving all processing areas) was placed directly into the program areas.

[3] Form 1120 "Giant" returns consist of the following: U.S. Corporation income tax returns, U.S. Small Business Corporation income tax returns and U.S. Income tax returns of foreign corporations (only insurance carriers) with total assets of $250 million or more; U.S. Life Insurance company income tax returns with gross assets of $1 billion or more; and U.S. Mutual Insurance company income tax returns with gross assets of $100 million or more.