Technical Papers

Number 67
June 1997

ROLE OF TECHNOLOGY IN THE CIVIL REGISTRATION PROCESS

International Institute for Vital Registration and Statistics
9650 Rockville Pike
Bethesda, Maryland 20814-3998
U.S.A.

FOREWORD

A few decades ago countries introduced advancements in technology to the civil registration process by adopting microforms for the storage and retrieval of vital records. In more recent years there have been numerous efforts to automate virtually every aspect of the civil registration process, and important applications of new technology have been introduced into the civil registration process in both developed and developing countries. This paper presents a brief overview of these developments.

This paper was originally prepared for presentation at the African Workshop on Strategies for Accelerating the Improvement of Civil Registration and Vital Statistics Systems, Rabat, Morocco, 4 to 8 December 1995, sponsored by the United Nations Statistical Division and the Economic Commission for Africa.

The program of the International Institute for Vital Registration and Statistics, including the publication and distribution of the Technical Papers, is supported by a grant from the United Nations Population Fund.

TABLE OF CONTENTS

ROLE OF TECHNOLOGY IN THE CIVIL REGISTRATION PROCESS

VITO M. LOGRILLO
INTERNATIONAL INSTITUTE FOR VITAL REGISTRATION AND STATISTICS
BETHESDA, MARYLAND USA

INTRODUCTION AND BACKGROUND

The question of advancements in technology and their application to the processes involved in the registration of vital events is one which has been addressed many times over the past decade in both developed and developing countries. What has been accomplished over this period reflects the application of technology in one or more components of the registration process. Reasons for the limited applications in registration programs are many and vary according to the status of a particular country's registration program. These include 1) the lack of a national, regional or local program to conduct the basic elements of civil registration; 2) difficulties in obtaining staff. training or equipment in order to apply the technology; 3) failure to recognize what the impact a civil registration system can make on programs related to health services and resources, primary care, population dynamics, and vital statistics developments in morbidity, fertility. and mortality; 4) unawareness of the utility the information from such a system can provide for program planning. review and evaluation; and, 5) failure to commit appropriate funding and support.

This is not to say technology has not been employed in the civil registration process over the years. Many countries have adopted the use of microforms (roll microfilm or microfiche) for the preservation and storage of vital records, and have implemented various types of retrieval systems to access these records. In some cases, computer-assisted microfilm systems (CAM) have been established which allow for the indexing and storage of microfilm records and rapid retrieval. Very early in the application of computers in the registration process, indexes of vital records - births, deaths, marriages - which previously were maintained in ledgers or on microforms were computerized and provided an efficient means of locating individual records regardless of how they were stored. This application was first used in the New York State registration program in the early 1960's. The automated index data elements included the individual's name, date and place of birth, and the given name of the mother. When a request was received for a copy of the birth record, the name was transformed into the Russell Soundex Code (1) to minimize the effect of the misspelling of names in locating an individual's record.

The momentum for registration programs to transition from a paper-based registration system to a paperless system reflect the many functions and responsibilities that civil registration represents. A long paper trail is often produced from the occurrence of the event to the recording of that event in the registration program at the local, regional and national level. The potential for lost or misplaced records, errors in abstracting and recording of the information, or the lack of reporting of the event is significant, and these factors must be considered at the outset in establishing a registration program. Obviously if legal, operational and administrative procedures are not in place, the transition to any type of automated system is unlikely to be successful.

The first phase of the automation process is to have the fundamentals of a registration program established under legal mandate by the national government and to have an effective means to administer and operate the program. Given this, whether the existing system is paper-based, microfilm (manual or automated), computer-based, or optical disk, the type of automated system appropriate to modify the program then becomes a critical decision in developing efficient, timely and responsive registration functions. Considerations for system selection are dependent upon costs, technical capacity, availability of training and related documentation, equipment and maintenance requirements, the physical environment (including electrical power, environmental controls, communications), and appropriate support staff.

At the present time, the primary focus of computerized processing of vital records has been in the area of vital statistics. Each birth, death or marriage record contains basic demographic data as well as medical and social data relevant to the specific event. For example, standard data are collected on the Certificate of Birth by most of the states in the United States in addition to other data of interest to the specific state. In all of the fifty states in the United States, these data are coded and entered in computer-readable format. These are then used in the preparation of vital and health statistics reports, for research and quantitative analysis, and for program direction and evaluation. The data are maintained on magnetic tapes or on disk storage systems and are also provided to the national government for use in preparing national vital statistics. Very little of this processing has been incorporated into the civil registration programs conducted independently by each state.

This focus on the automation of vital statistics programs is changing however. Up to now, the registration activities have been a low priority. As long as a copy of a certificate could be prepared, the system was thought to be adequate. This is no longer the case. Major shifts in the requirements for documenta-

tion to receive public service support. increasing mobility of the population, and decreases in program staff due to serious budget deficiencies has led to reconsideration on how to have an effective and low cost registration system. The primary focus is now on reducing costs and at the same time maintaining a responsive program. This has led to a variety of approaches for automation of registration functions and operations.

AUTOMATED SYSTEMS

There are a number of factors to consider when addressing the questions related to the establishment of automated systems for use in the registration process. First and foremost are the characteristics of the current registration program. Record volume. the number of daily transactions such as record corrections and amendments, indexing, security, and data integrity all dictate the direction for establishing an automated system. Currently, automated systems development for civil registration activities include computer-based systems, optical disk systems, and computer-assisted microfilm systems. The system of choice, and the operational program to be the focus of the automation effort, is largely based on the attributes of the existing registration program, areas where support is needed most, and the physical environment. Each of the above systems provides unique functional capabilities, and requires a complete review and evaluation prior to system selection and implementation in the identified areas of need.

Technological advances in computer software and hardware, and in other media such as optical disk and microfiche systems, allow for mass storage and rapid access and retrieval of information. Subsequent processing of transactions against the established database, the preparation of record copies and reports, and the compilation of related statistics have become much more efficient and economical than in existing manual systems. This technology is now more frequently being considered by many countries for implementation in civil registration. The utility and effectiveness of automation in terms of costs, operational productivity and timely system responsiveness are major reasons for re-directing programs to an automated environment.

For computer-based systems, a major consideration is data entry. In a registration program which is totally paper-oriented, this is a significant cost and time factor in getting the system up and operational. It is often necessary to concentrate on selected years representing the highest volume of activity for initial placement into the system, and moving forward in time with current records. This approach gives immediate benefits in reducing workload and processing, while building a fully automated system for the future. Where previous years of data are already in machine-readable form that is, are contained on magnetic tapes or disks. the movement to a fully operational computer system becomes a more meaningful option.

Within a computer-based system, record storage and retrieval, indexing, record searches, corrections, and the preparation of record copies for transcripts or certifications are quickly and easily processed. and the security of the data is maximum. Such systems can be developed in a networked personal computer (PC) environment or on a mainframe system depending on the volume of records and related processing. PC's may have several hundred megabytes of disk storage with processors operating at very high speed, and contain networking and communications capabilities. These factors bring computer systems for civil registration activities down to reasonable costs, with relatively small physical environments required for the equipment. and highly "user-friendly" software for operations and training of staff.

An alternative to the computer-based system, particularly as this relates to large existing paper-based systems where data entry would not be feasible. is the use of optical disk. In this type of system, the record is scanned and placed on an optical disk. An electronic index is created at the time of scanning, allowing search and retrieval of records at electronic speed. Optical disk gives an exact replica of the original record as opposed to the computer-based data entry system where only selected data are in the system in digitized form. In addition, storage capacity of a single disk can range up to a million records.

Optical disk provides for massive storage in minimal space; provides for efficient retrieval of records; and. produces exact copies of the original record. New technology is currently underway in this area which will allow for corrections and amendments to be made directly to the records on the disk. However, the data cannot be processed to produce related vital statistics. This is the advantage of the computer-based system in that all of the data in the computer can be processed to prepare reports, statistical summaries. and to conduct research utilizing the computer data base. as well as to complete all of the processes related to civil registration.

Between these two types of systems is the computer-assisted microfilm (CAM) system. This system takes advantage of the fact that many civil registration programs have instituted a microfilm system for record storage, retrieval and copy preparation. This technology has been in existence for many years and has been implemented in many countries. Enhancements have been made by incorporating electronic technology into the system. Existing microfilm, in roll or fiche form, can be integrated into a computer-based system which then allows processing to take place at significantly higher speed than the original microfilm processing equipment. Through electronic indexing the microfilm can be searched and records retrieved very quickly. Where microfilm has not been previously used and documents still remain in hardcopy form, the documents can be filmed very quickly and placed into the CAM system.

Processing for statistical purposes and related analytical usage is not feasible with microfilm images. Also, corrections and amendments to the record, since it is on film, are not as efficient as in the computer system. Since the system has a microprocessor, search and retrieval of registration documents is at electronic speed. This type of system, as with optical disk, is best

suited where the activity is focused on registration functions that is, record storage. retrieval. and copy preparation Data processing for statistical purposed and for report generation and analytical uses of the data are best accomplished in the computer-based system.

Because of these differences, it is essential that in selecting an automated system or the functions to be automated for civil registration, the total expectations and purposed planned for the records and the data must be fully described. Where record storage and processing is the major goal, optical disk or CAM systems can provide an effective system for operations; where there is need for data processing for statistical, epidemiological, and research purposed in addition to the registration functions the computer-based system provides the greater flexibility. And. of course, a combination of the two can be implemented to effectively produce a system to meet each aspect of registration and vital statistics.

It is clear that the technology exists to bring civil registration into an automated environment. System costs for software. hardware. equipment maintenance and training have been reduced to levels where these can be adapted in most countries. And, where such systems have been implemented. the resultant cost-savings, timeliness of processing, staff efficiency, and applications development have significantly outweighed the initial investment to become operational.

APPLICATIONS FOR REGISTRATION FUNCTIONS

The application of computer technology to the administrative and operational activities of civil registration has in recent years received major attention in state programs in the United States. In the past, computerization had focused primarily on the vital and health statistics and research components of state vital registration systems, with registration functions continuing in a manual mode. Some developments in automation have occurred over the years, but most of these efforts have been directed to the solution of individual problem areas such as record storage or indexing.

More recently. automation has been extended to encompass all of the operational functions of civil registration with the goal of developing a completely automated registration system. Several states in the United States are very close to realizing this goal, with many states now directing major resources to implement such systems. Over the next five years, most states will have significant portions of their registration activities fully automated, with several approaching a "paperless" system.

Many countries have experienced increased demands on the registration system for services and for the population and health data that can be derived from the system and have responded by moving toward automation. The directions taken in these countries differ in part due to their unique requirements. the present status of the existing system, and to some extent due to availability of staff, equipment, and training These are limitations to implementing computerized systems, but decreasing costs for computer equipment, and user-friendly software are rapidly making such development feasible and affordable. Specific areas include data entry, record processing. indexing, record storage and retrieval. certificate forms, amendment and correction of records, data transmission and microfilm systems.

Data Entry, Storage and Retrieval

Several approaches have been taken in resolving the problems associated with entering data from vital record forms. Traditional processing methods have the forms completed in the field, and submitted to the central registration agency for coding and data entry. This requires substantial resources in terms of staff, equipment and storage space. As these resources become more costly. alternative methods of getting the data into an automated format have to be considered.

One method is to have the coding and data entry occur at the source of the event such as the hospital or clinic. Records can be transmitted electronically over telephone lines or, the data can be copied and submitted to the registration office on floppy disks. This process employs a microcomputer (PC) located at the site which contains a software package to display the certificate form and to perform certain editing functions. Staff enter the information on the displayed form, which then undergoes an editing process on the PC. Edit checks include such items as verifying that data fields contain only appropriate alpha or numeric data; codes for selected variables are in the proper range; and variables such as age, date of event, and residence are accurate.

This approach eliminates the need for a centralized coding and data entry staff, and minimizes the need for interchange of certificates from the official registration office with the hospitals or clinics for corrections or incomplete data. This significantly improves the timing and availability of the data both for registration and vital statistics purposes. Estimates indicate that data entry requirements are reduced from 40% to over 60% at the central agency level, coding is reduced by 50%, and the timeliness and availability of the data is increased by nearly 80% These percentages reflect differences between manual and automated processing.

Costs of the equipment and the software for this type of applications can range from $2,500 to $5,000 depending on the size of the system. Inclusion of other types of vital records to the system requires only an additional cost for the software packages for each record type. This is estimated at $500 to $900 for each type of record. No additional equipment is required for these additional records since the disk capacity for PC's can be easily expanded at reasonable cost. Costs for equipment and software would be required for each site from which the data is entered in order to implement remote processing.

A second approach being taken is the use of optical disk systems for record storage. retrieval and printing of copies of records. Certificates completed in the field are forwarded to the central agency for coding, scanning, and indexing for entry into the system. This type of system produces a high quality image that does not

suffer from deterioration such as found with paper documents or microfilm. A high resolution scanner is used to electronically capture record images, which are stored on optical disks. A computerized indexing system provides for automatic searching of the documents, with the amount of data entry for the index directly related to the number of variables needed for record identification. Generally these include name and soundex code, date of the event and place of occurrence.

This system also provides the capability to enter selected statistical data at the time of preparing the index to allow for the development of selected basic vital statistics data along with the processing of routine registration activities. In this way a fast, cost-effective and efficient processing system for meeting registration demands of the population as well as providing a capability for preparing relevant vital statistics can be achieved. The types of statistical variables are limited and relate primarily to demographic information for descriptive purposes only.

Costs associated with optical disk systems vary widely, depending on the size of the system and the applications to be included. The growing use of PC-based optical disk systems makes their use in various applications cost effective. Optical disk provides an exact copy of the original document and incorporates the full capabilities of a computerized system to locate, link and process the documents. A major savings in data entry staff, time and resources are also realized with this type of system. Such systems, including scanning equipment, computer and processors can range from $10,000 to $100,000 depending on the size of the application.

Completely computerized systems for record storage, processing and retrieval in which the certificate data are keyed and stored on disks on mainframe computer systems are also being developed. This approach has a significant data entry cost associated with it, particularly if multiple years of data are to be placed into the system for both registration and statistical purposes. It does however afford the greatest degree of flexibility in terms of total document processing. Copies of the record can be prepared, corrected and mailed electronically; complete indexing parameters are available for record matching and retrieval; updating of data is done without the need to create or modify paper documents; and information is readily available to multiple users and for multiple uses.

Indexing of Records

A key element in each of the systems described above is the indexing of the stored record. In all cases, automated systems have a computerized index for record search and retrieval, whether the systems are computer-based, optical disk or CAM systems. Information contained in the index generally includes name of the individual, date of the event, residence of the individual, and place of occurrence of the event. Other variables such as sex, race, names of parents may be included. In most instances, the index may contain sufficient information to produce a certification of the record.

Different methods for indexing are used for locating a record, including a straight alphabetical search on the surname and/or given name, use of Russell Soundex code(1) (which can be generated automatically by the computer), NYS Identification and Intelligence System code(2) or other algorithms based on the name of the individual. In addition to the alphabetic name or code, the date of the event and place of occurrence are usually all that are needed to locate the record. In an index listing containing over 5 million records, an average search time for a specific record on a PC is under 10 seconds, depending on the size of the computer and the algorithm used. Where indexes contain sufficient data for the preparation of a certification, a certification form can be printed simultaneously.

The savings in time and staff of a computerized index as compared to manual searching using index books or manual microfilm-based indexes are significant. The cost of disk storage has decreased to the point where a computer index on either a mainframe or microcomputer system is a highly cost-effective and efficient method for record searching and retrieval. The algorithm used to encode the name of the individual to whom the record relates must be carefully considered. For example, the Russell soundex code eliminates all vowels contained in a name in arriving at the code to be used in the search. This may not be an effective code for records where multiple vowels are common occurrences in family names.

Electronic Birth Record

The major area of development at the present time in the civil registration area in many states in the United States is the electronic birth certificate. Births account for the largest volume of records and require the greatest amount of registration activity, thus representing the single most cost-effective record for automation. The amount of information collected on the birth certificate, the number of copies issued annually, the amount of processing for corrections and updating, and the variety of applications for use of this record far exceed those of all the other types of vital records. It is because of these characteristics that the birth record is the first record to be computerized in many registration programs.

There are a number of advantages to computerizing the birth record. First and foremost is the fact that the birth record is completed at the originating source. This affords a convenient location to place equipment, provide training, and to establish standards for operation of the system. In doing so, immediate benefits are realized with significant reductions in transcription errors, incomplete reporting of data, the need for follow-back queries, and in lost certificates. Once the data are entered at the hospital, the data are immediately available to the hospital for its own use, as well as in a format for printing and for transmission to the state agency. A printed paper copy, if needed, may be routed through a series of local agencies prior to final storage at the central office. However, since the data are transmitted electronically there is no delay in the

availability of the record Records can be instantly regenerated either at the hospital or at the central registration office without the need to reenter any of the data.

The security afforded by the electronic system is not readily reproducible in a manual system. Information received only via the electronic system are validated as official records. Fraudulent paper copies of certificates cannot be added to the system and can be identified through cross-matching of the paper and electronic documents. Entry of data into the records can be done only by authorized staff through a series of controls on identification and password access to the computer system. Any irregularities in the system related to registration data can be quickly identified as to the staff authorized to have access to the computer. All changes to the record are controlled through the electronic system, and can easily be restricted in terms of what changes can be made and by whom.

The electronic birth record also affords a number of processing features which reduce the need for subsequent record corrections or changes. The audit/edit features built into the system include spelling checks, data validation, auto-coding of selected variables such as institution and geographic locality through the use of look-up tables, single entry of common data elements such as dates, and automatic calculation of variables such as length of gestation (based on the dates of delivery and last menses) or conversion (eg pounds and ounces to grams). Each of these features saves significant processing time, reduces the need for subsequent changes to the record, and minimizes many types of errors.

The computerized system also provides the flexibility for local access to computer-based birth records. Communication networks can be established whereby an authorized local or regional registration office can access the central computer, initiate a search for a record and have the information transmitted and printed on a birth certificate form in the local office. This is a growing area of development, the decentralized access and retrieval of records for registration purposes.

The transmission of data to the central registration office from the hospital for the electronic birth record takes one of several forms. The data, when entered on the microcomputer at the hospital, may be copied to a diskette and mailed to the office. The diskettes are then uploaded to the agency's mainframe or microprocessor which contains the birth registration database. Generally this is the first option used when initiating remote preparation of the record. A second method is to process birth records at the hospital and prepare a database for subsequent transmission electronically over telephone lines This approach has been implemented in a number of registration programs primarily in hospitals which have a large volume of births.

The electronic birth record, where it has been implemented, has minimized the need for manual intervention in the processing of the record, and has provided significant improvements in 1) the quality of the data as received from the source. 2) the timeliness of receipt of the data, 3) efficiency in processing changes and corrections, 4) maintaining security and confidentiality since fewer staff are necessary to handle the records, 5) availability of the data for multiple use and users. 6) electronic search and retrieval of documents and, 7) minimal physical storage requirements and handling of the documents.

OTHER REGISTRATION APPLICATIONS

A number of other automated registration activities with regard to the electronic record which have been developed include transaction processing, billing and accounting features, and direct mailing of both registration materials and information related to maternal and child health. These are labor-intensive activities which lend themselves very readily to computer processing. Examples of the types of activities which have been automated include:

1. *Key Entry*

- Edits records (replaces former manual edits).
- Writes letters asking corrections for errors (replaces manual system).
- Codes entries automatically (replaces manual coding system).
- Allows on-line update for corrections and amendments (replaces manual coding and batch entry).
- Allows entry of indexes for historical records.

2. *Correspondence*

- Allows entry of administrative information for all requests for documents (replaces 5-part paper receipt form).
- Allows tracking requests in response to inquiries from the public or from law enforcement.

3. *Fee Tracking and Accounting*

- Accounts for all fees received (replaces paper documents needed for audit purposes; partial replacement for manual deposit requirements).

4. Issuance of Certified Copies

- Allows immediate search and issuance of birth certificates (replaces manual search and photocopy of record).
- Allows legal amendments to birth records (replaces 2-part paper certified copies).

5. *Production of Administrative Reports*

- Indexes for use by central and local registration offices.
- Fiscal reports for budget, deposits, special accounts.
- Administrative workload reports for registration section.
- Report on field offices.
- Notification of registration of parents.

6. *"New" Record System*

- Preparation of new accurate certificate following adoption or paternity action (replaces manual correction process)

- Update database with "new" information (expedites updating of record data base).
- Cross-reference information, new/old name, for tracking impounded records for the registrant (newly available process)
- Notification of changes to local offices.

Each of the above automated functional registration areas has significantly changed and improved the operation of the registration program. Within this context, it should be noted that these benefits go beyond those associated solely with the registration functions. Software packages such as word processors, data base management systems, and spreadsheets can be incorporated into the microcomputers used for the registration system to further enhance processing and productivity. Examples include correspondence to consumers prepared using a word processor; a series of workload statistics compiled from a spreadsheet; and, integration of data from other administrative records with information contained in a database management system.

SUMMARY

The development, application and implementation of automated registration programs have in recent years moved at an accelerated pace. Impetus for the change can be found in the increased demands of the population for registration services, declining staff resources, and technological advances which make automation a feasible option. The directions being taken vary and include systems utilizing computers, optical disk and computer-assisted microfilm. Each approach is designed to meet specific needs of the particular registration program.

The direction a particular registration program takes, be it a local, regional or national system, should draw from the developments which have been made in other registration programs. Where computerization has occurred, computer programs and systems which have been developed may be made available to other registration programs which are considering implementation of automated systems. It is clear that there is a need for automation as record volumes grow, demands for services increase, and resources and funds decline which are necessary to provide services. Registration activities have not drawn the funding or resources as compared to other programs. This is changing, however, and much of the new efforts are being directed to upgrading programs through the use of automation.

Costs to initiate a computerized system for registration vary widely. Many programs have taken a stepwise approach, automating current registration functions or selected activities and incorporating older records and related processing functions at a later time. This reduces the need for major expenditures for data entry or scanning and indexing of records, computer equipment and software, training and redeployment of staff. For registration programs having low volumes of records most of the processes described above can be accommodated on microcomputers.

Other options which permit gradual movement to an automated registration system include microfilm systems utilizing computer-assisted retrieval and optical disk systems. These systems also offer computerized indexing capabilities for record search and retrieval. One of the difficulties associated with these systems is in error correction and updating. Changes to microfilm are difficult, usually requiring the creation of a separate record copy and subsequent storage and indexing of the new record. Current optical disk systems are also in this category, where most have "write once, read many" disk. This means separate images must be made for corrected or updated records. The flexibility of the electronic record is clearly superior in this regard. Compared to manual systems, however, both microfilm and optical disk systems offer major advantages.

The question of the capability to transfer components of automated systems from one registration program to another is one area which needs to be explored in more detail. As countries move toward the development of automated registration systems there is a clear benefit to have available the information of what has occurred. Not only are mistakes and problems minimized, but the potential use of software and the processes and procedures which have led to successful operational systems can significantly reduce costs, efforts and time in other programs. The impact of automation on civil registration programs in general will produce positive results, and in the longer term provide a basis for standardization of civil registration programs on an international level, providing immediate interchange of information for registration purposes, technical assistance and support.

REFERENCES:

(1) *The Art of Computer Programming, Sorting and Searching*. D.E. Knuth, Volume 3, Addison-Wesley, 1973.

(2) *Name Search Technique,* NYS Identification and Intelligence System, Bureau of Systems Development, New York State. NYSIIS Document No. 209, August 1970.