Chapter 4

The Future: The Necessity of Long-Range Technology Planning

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The Social Security Administration badly needs well-developed and effective long-range planning capability. The Systems Modernization Plan deals primarily with technology, and secondarily with technology management. It will be most effective if it is implemented and extended in the context of an institutional long-range plan that provides insight about how the agency mission will change over time, alternative ways of performing that mission, the resources that will be available, and the capabilities that will be needed.

Technology is an essential element in SSA'S future. But technological forecasting and assessment, even if greatly improved at SSA, will not constitute a long-range planning capability. Factors other than technology will influence the organization's future, such as changes in its mission, resources, and relationships with other institutions; and these factors shape the purposes and goals for the technological systems. Some of these factors are within SSA'S control, and some are not; but continuing monitoring and analyzing of such factors can allow the agency to be prepared for changes and make a smooth transition to new ways of fulfilling its mission.

ELEMENTS IN SSA'S FUTURE

SSA'S Mission

SSA'S basic mission is unlikely to change significantly over the next decades. There will almost certainly be congressionally mandated changes in coverage, entitlement provisions, benefits, etc. Some of the programs now administered by SSA could be removed, or other responsibilities added, with additional requirements for data collection and handling. New social programs that might be assigned to SSA, however, usually have long gestation periods, and the assignment can be anticipated by agency planners.

SSA'S mission therefore is, and is likely to remain, more stable, coherent, and routinized than that of many government agencies. This is a significant advantage for long-range planning.

The objective for planners, in this situation, is to help the agency define its goals and priorities in carrying out its mission, and to help it set reasonable standards of performance in terms of quality, timeliness, and costs of service delivery. At present, the agency is unable to respond with credibility to either the Office of Management and Budget, Congress, its employees, or its critics on questions related to the realization of productivity gains, the most manageable rate of work force reduction, and the appropriate timing of further procurements, largely because it has not explicitly defined its goals and milestones in a way that can be credibly justified. Looking beyond the nexts years, a long-range plan should provide alternative technological and institutional mechanisms for service delivery in the context of evolving needs of the clients and future capabilities and costs of information systems.

The functions essential to carrying out SSA'S mission involve:

- data collection;
- data processing;
- data protection (privacy and security);
- service delivery;
- accountability and information dissemination (providing information needed by the Administration, Congress, and the public); and

- coordination with other Federal and State agencies.

Each of these is subject to change. New kinds of data may have to be collected, new services may be mandated, law and public policy may set new standards for data protection and accountability, and new technology will change both the available techniques for and the costs of performing all of these functions.

The Placement and Structure of the Agency

SSA might at some time be separated from the Department of Health and Human Services and be given the status of an independent agency. The most important changes in management and reporting responsibility would in this case be mandated by law. The most likely structure of agency leadership is already apparent from legislative proposals before Congress, and should therefore not take the agency by surprise.

Internal reorganizations are a more immediate and more likely possibility, and have significant implications for long-range planning. Information systems development and planning to be most effective must reflect and support the flow of work–i.e., the movement of information and the sequencing of steps in its processing —through the organization. A long-range planning process that enabled the agency to define its goals and priorities could provide a valuable guide to organizing the agency for greatest effectiveness. It would allow the phasing in of desirable changes in a logical and orderly manner, providing at the same time a rationale and justification for the changes to managers and workers. Conversely, the relationship between programs (OASI, SSI, etc.), between operations and systems development components, and between field offices, Regional Commissioners Offices, Program Services Centers, the National Computer Center, and headquarters staff, should be considered in establishing a planning unit and determining its responsibility, location, role, and reporting processes.

Staff Changes

This may be the most immediately challenging and least adequately considered element in SSA'S future. Technological change, congressional budgetary decisions, and Administration policies are pressing toward significant changes in SSA'S work force, but the agency is responding in a largely reactive rather than proactive mode. A rational and persuasive plan for reconciling and mediating these pressures could allow the agency to shape and influence decisions that will finally be made or sanctioned outside the agency.

The groundwork was laid for an innovative approach toward cooperative labor-management adjustments to change, but there are indications that this promising start is being allowed to wither. Unresolved questions involve recruitment, training, job classification, compensation adjustments, promotion, relocation, working conditions, labor-management relations, and retirement policies. All apply to managers, professional staff, and clerical staff, but there are different needs and constraints for each group. These needs and constraints are intimately related to changes in technology, and to Administration policies, the two factors with which long-range planning will be primarily concerned.

Clients

While SSA'S mission is basically simple and stable, there will be changes in the demographic makeup of its clients over the next two decades, which will or should affect the way in which the mission is performed and the criteria for excellence in performance. For example, the age distribution, educational level, ethnicity, language problems, technological sophistication, and family resources of beneficiaries and their survivors may change significantly. Some of the problems which occurred with implementation of the SS1 program illustrated the way in which changes in client needs and expectations determine the effectiveness of traditional SSA procedures.

TRENDS IN INFORMATION TECHNOLOGY

New advances in information technologies and related management tools, beyond those envisaged in SSA'S 5-year Systems Modernization Plan, are available now or are reasonably certain of becoming available in the near term, and can be rationally anticipated and planned for (see table 3). They will be the standards by which experts will evaluate SSA systems and management in the 1990s. Unless SSA begins now to systematically prepare for modernization beyond a 5-year horizon, it may again find itself falling far behind the "state-of-the-art" at which SMP is aimed.

SSA has historically emphasized heavy-duty computing needs of the core administrative functions-the processing of enumeration, earnings, and the master beneficiary file. Other uses for computing will be increasingly important.

Some new developments in information technology will be useful chiefly for advanced scientific research, at least in the near future, but such capabilities are generally soon adapted to the more prosaic operations of corporate and government institutions. Monitoring these developments and trends as they emerge will be necessary if SSA is to plan to use new technical capabilities when they become reliable and cost-effective.

Other technical capabilities are already available and in use in leading private sector organizations and in some government agencies. Some of these do not, however, yet appear in SSA'S Systems Modernization Plan, or are only incorporated as eventual enhancements rather than as pivotal points of leverage for making optimum use of information systems.

For example, to use information technology to the fullest in improving its management of operations, SSA will need to develop more powerful administrative processing and management information systems, designed to access transactions information and manipulate it to answer managers' questions. These management information systems could also aid Congress in oversight of SSA, although as pointed out above, they could also be used, unfortunately, to select and present only favorable indicators and benchmarks.

Table 3.—New and Potential Technology for SSA Functions

Function	Technology
Communications	Local area networks
	Electronic mail
	Private branch exchanges
	Digital switching and transmlssion
	Fiber optics
	Communications satellites
	Cellular mobile radio
	Data encryption
	Integrated Services Digital Networks (ISDN)
	Voice mall
	Teleconferencing
	Two-way cable
Data collection	Home computers
	Client-operated devices (similar to ATMs)
Data input	Optical character recognition
	Voice recognition
Data output and presentation	Computer graphics
	Voice synthesizers
Data processing	Minicomputers
	Relational databases
	Query-by-Example
	Multi-use super-micros, application software packages
	Supercomputers: multiple instruction multiple data (MI MD) processors, vector processors, data driven processors, FORTRAN programs
	Parallel processing
	Associative processors
Entitlement evaluation, adjudication	Spreadsheet applications
	Expert systems
Storage	Magnetic bubble devices
	Wafer-scale semiconductors
	Optical disks
	Smart Card

SOURCE Off Ice of Technology Assessment 1986

Software Trends

Software development has historically lagged behind hardware development, but it is now a major focus of information science research and development in the United States and in other nations, and can be expected to move rapidly over the next decade. Major trends in software that could be better utilized by SSA are:

- *Enhancements to Systems Analysis and Design:* These tools, called "interactive requirements analysis tools, " are designed to codify data, reduce errors, and improve the documentation required when establishing the requirements for a large information system. They fall into the larger family of tools called "structured analysis, design, and programming techniques. " New ones use forms-based systems to achieve uniformity of documentation and design, by prompting the designer with questions and blanks. They improve compliance with programming and design standards, which has been one of SSA'S problems. Others help the systems analyst to put the systems design in a particular format or notation that can be fed into a code generator for key parts of a computer program. These software design tools can in the future be incorporated into larger automated design tools.
- Code *Generators:* These are computer programs that assist programmers in quickly producing third-generation language programs, for example, COBOL programs. One is Quick-Code, which generates DBase II programs; others are Quick-Pro, the Producer, and Genasys. Some reports have shown productivity gains approaching '75 percent with the use of these code generators.
- *Development of Fourth-Generation Languages:* These are computer languages that use English-like vocabulary and syntax, and are useful for the development of administrative and management information systems. The distinction between fourth-generation languages and database management (software) systems is in fact becoming ambiguous, and often depends in part more on who will be using them (systems developers or systems end-users), than what they can do. For programmers, these computer languages can m-educe order-of-magnitude increases in productivity; it is estimated that most fourth-generation languages result in 10 times greater productivity than COBOL. Most of these languages are not yet capable of being used for sophisticated applications but they are likely to be so in the future. In the area of management information systems, they are now capable of providing responses to most kinds of questions needed for reports. Examples are FOCUS, RAMIS, SQL.
- *Relational Databases:* These database structures (ways of organizing data) permit great flexibility yin the ways of asking for information, and they use English-like fourth-generation languages in addition to being compatible with COBOL and other third-generation languages. Examples are Univac's Mapper, Culinet's IDMS, and IBM's DBase-II. Relational databases are now a small but rapidly growing portion of the data storage and retrieval market. For high-volume applications they are still too slow; as of yet they cannot be used with very large, heterogeneous databases with many thousands of records, but very powerful computers may in the future enable SSA to take advantage of them.

Developing and maintaining software is now the dominant cost of creating and operating large computer systems. Advances in microelectronics have steadily reduced the cost and improved the performance of hardware, but improvements in the productivity of programmers has been much more difficult to achieve. Software engineering, techniques for improving the productivity of programmers and designers, is increasingly important. Research in this field includes highly theoretical work directed at fundamental understanding of the nature of programs and "proof," in some mathematical sense, that they will work as intended. At the other end of the spectrum, it includes behavioral science research on the ways in which people interact with computers (the "man-machine interface' and techniques for management of programming tasks.

Artificial intelligence is a field of research concerned with extending the ability of the computer to more nearly match human mental capabilities, such as recognizing and understanding speech and visual images, reasoning, choosing among options, or deciding, and spontaneously communicating. The first significant commercial applications of artificial intelligence, after at least 25 years of research, are in the area of expert systems. These are "intelligent information retrieval systems designed for use in tasks requiring expert knowledge, such as insurance underwriting, medical diagnosis, weapons control, or business decisionmaking. Expert systems store not only data, but rules of inference that describe how an expert would use the data to make decisions. The expert systems' rules of inference are derived from analysis of the decisions of many experts, and can therefore make a user's decisions more comprehensive, more rigorous, and more consistent than those of a typical user who is not in the top echelon of experts in the field, and at least in theory better than the decisions of any one expert might be. Since insurance underwriters are already using expert systems, applications for SSA claims representatives, or State determiners of disability, are an obvious possibility to be explored.

Hardware Trends

In order to run sophisticated languages and relational databases, faster and cheaper machines with new capabilities are needed. The faster and cheaper the machines become, the easier and more economical it is to use languages which are less efficient but more suitable for use by nonspecialists. The following developments should be helpful for SSA:

- *Database Machines:* In order to operate relational databases at reasonable speed, it is necessary to use parallel processing, so that several operations can be done at once. A database machine is several orders of magnitude faster than other machines; some are on the market that can execute 10 million instructions per second and speed up database transaction processing 10 to 20 times, reducing the cost of these operations.
- *Increased Power:* It is likely that in the next toyears the cost per unit of computing power will continue to decrease and the speed increase, as they have in the recent past. Supercomputers—or advanced architecture and parallel processing-may become available to very large organizations like SSA; allowing processing at much higher speed and much lower unit cost. The need for sophisticated cost-effectiveness comparisons of systems in the future will be of increasing importance.
- *Mass Storage Technology:* Magnetic disk storage technology continues to improve incapacity and cost, but laser optical disk technology offers storage of up to 2.5 billion bytes on one 12-inch disk, several orders of magnitude more density than possible on a magnetic disk. There are still a number of technical problems related to the use of optical disks for organizations with immense databases like SSA'S; for example, improved computer-controlled indexing systems are needed, and there are unanswered questions about their archival 'shelf life. Until very recently, optical disks could not be used in a read-write mode; since they could not be changed once data was recorded, they were useful only for permanent storage. Several firms are now working on erasable optical disks. Some commercial applications are available and others are nearly ready for market. Access time for erasable optical disk systems may continue to be a problem because of the enormous volume of data they can hold, but they clearly promise superior performance in comparison to existing sequential-access magnetic tape systems.
- *Communications:* SSA does not have much in the area of local area networks (LANs), PBXS, and wide-area networks (WANS) to link computers in buildings, cities, and counties. Failure to take advantage of these technologies will prevent it from developing efficient office automation and enhancing productivity in local district offices.

- *Optical Character Recognition Technology (OCR):* OCR is now undergoing a spurt of rapid development. Typed or printed material can be read into the computer 40 to 50 times faster than it can be keyboarded. State-of-the-art OCR equipment can read up to 23 different fonts with an error rate smaller than that of an accomplished data-entry clerk, and some of the devices can also handle simple hand-printed notations, such as numerals. Within the next few years, OCR should have the capability to recognize, isolate, and read or copy specific bits of information within a larger volume of data.

New concepts of computer architecture now being explored in the laboratory will provide two waves of innovation: highly specialized, low-cost computer modules that do specific types of tasks at extremely high speeds, and future generations of supercomputers. '

Because computer hardware has in the past been expensive, users have tried to allocate its cost over a variety of applications and uses, with general-purpose mainframe computers. But as the costs of hardware drops, some computational tasks, involving high-volume standardized data, may in the future be done on inexpensive, special-purpose hardware with the general-purpose computer used as a routing switch, sending a computing task to one of several different specialized processors.

The term supercomputers is used for the most powerful computers available at any one time. The next generation of supercomputers is likely to have a radically different "architecture. " Computer architecture is the internal structure of a computer, the arrangement of the functional elements that carry out calculations and manipulation of data. Since their invention, computers have basically followed one model, the von Neumann sequential processing architecture. The limits of computational speed that can be achieved with this design are being approached, and further increases in computer performance may require parallel processing architectures. That is, operations performed on the data would be decomposed into tasks that can be simultaneously carried out by many computational units working in parallel.

Very large-scale integrated (VLSI) circuit design facilities, using the most powerful computers, are being used to develop and test new architectural designs. Three U.S. companies (CRAY, Control Data Corp., and Denelcor) are developing "next generation' supercomputers, as are several Japanese companies. Japan has embarked on major supercomputer projects that may challenge U.S. leadership in supercomputers. One, called the Fifth Generation Computer Project, is aimed at producing a computer using artificial intelligence, or reasoning functions similar to human thinking processes.

Management Tools

SSA has adopted new software engineering techniques such as project management systems, automated documentation systems, report generators, screen editors, database management systems, etc. Already, however, some private sector organizations are moving from this software engineering technology approach to methodologies such as prototyping the end-user development (some of these new tools were described above under software trends). SSA should test and evaluate these newer technologies as soon as it has a database on which they can operate.

Federal agencies are required by the Paperwork Reduction Act to introduce information resource management (IRM) as a concept and organizational tool. This includes the creation of a data administration function and a data administrator's position at a high level in the organization. The concept of IRM is still controversial and poorly implemented in most Federal agencies and in private organizations. Nevertheless, it is important that SSA take a fresh look at the implications of this concept. It will need, for example, to put greater em-

[1]Much of the material in this chapter is based on an earlier OTA report, *Information Technology R&D: Critical Trends and Issues, OTA-CIT-268* (Washington, DC: U.S. Government Printing Office, February 1985).

phasis on development of organizational devices such as Information Centers, to help and support end-users.

If SSA is able to adopt new technologies, a large shift in data-processing skills will be required, from traditional complete reliance on COBOI. programming toward greater capability to work with fourth-generation languages. There are vast differences in the skills required. There will be an increased need for database designers and administrators, code optimizers, structured analysts, prototypes, data comnlunication network specialists, and decision support specialists. A large number of professionals will have to be recruited or retrained to produce the required labor force by the 1990s. Since many experts estimate that the stock of useful knowledge which a program~-mer has is depleted by one-half every 5 to 7 years, SSA'S technical training programs will be increasingly critical in terms of upgrading technical knowledge on a continuing basis.

SSA'S CONTINUIN~ UNCERTAINTIES: DECISIONS ARE NECESSARY

SSA'S response to its 1982 problems must be understood in terms of the technologies that were available. Much of the criticism of SSA'S Systems Modernization Plan rests on the perception that SSA did not, in 1982, pay enough attention to the wide diversity of options available to it; and in the intervening 4 years it is not clear that SSA has developed an understanding of the rapidly developing and diversifying technological options that it will have in the future.

By 1982, it was no longer necessary for an organization to arrange the entire computing function in a large, centralized, information systems department; machine intelligence could be distributed throughout the organization wherever needed. In addition, microcomputers, mainframes, minicomputers, and peripheral devices can be tied together with PBXS or LANs.

The 1980s is also a period of tumultuous change in the organization and marketing of telecommunication equipment and services. Many large organizations are bypassing local telephone companies by using their own fiber optic or microwave intracity telecommunication networks. The deregulation of the telecommunication market has led to an explosion of offerings of new telecommunication services, and rapid reduction in the price of both long-haul and local telecommunication costs. Managers must take more responsibility for making key decisions about protocols, organization, and maintenance, which heretofore the telephone companies had assumed.

By the 1980s, database technology has allowed a shift in thinking about data from "information as a cost" to '*information as a resource. " In the 1970s, information was usually highly fragmented among different levels of the organization, different specialized functions, and different computer programs. It was difficult for specialists in one division to share data with those in another division. Database management in the mid- 1980s means:

- codification of data elements to define common meanings and to catalog origins and uses (a data dictionary);
- reorganization of data elements from thousands of computer files into a single pool or "database";
- separation of application programs from the data elements, by use of a database application development language; and
- reorganization of data elements to permit greater flexibility in responding to inquiries.

It must be recognized, however, as has been stressed throughout this report, that SSA'S performance and problems are not greatly different from those of other organizations attempting to catch up with and stay abreast of broadening technological capabilities. The implementation of true corporate and governmental databases is 5 to 10 years behind the idea, because existing software has to be amortized, there are significant organizational costs involved, hardware must be upgraded, and top management is often not convinced that the large costs are actually justifiable.

The principle themes in software today are higher level languages, user-friendly languages, automatic code generation and software engineering. Information now plays a strategic role in the operation of many organizations. The nonspecialized general user has become more important; computer specialists no longer have a monopoly on data processing. There are more hardware, software, and services options. Organizations are less bound by the limitations of their data-processing staff and can develop systems faster and in a more rational, planned manner. There is increasing recognition of the close connection between systems and organizational structure, and of the fact that relatively large changes in organizational structure may be necessary to take advantage of new technologies.

In 1985, debate about social security issues has receded, and congressional attention has been focused primarily on SSA'S continuing attempt to modernize its technology and its management. This attempt is making progress, but its promise is limited by SSA insistence on looking only 5 years ahead.