Micros and Mainframes: Emerging Systems to Support HRP's Newer Roles

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Executive Summary
This article suggests ways that currently available computer technology will likely affect the state of best practice in human resource planning in the near future. The author sees planners increasingly accessing mainframe based, public data bases in order to speed up the research they conduct before implementing new programs and to obtain data on competitors to make strategic human resource plans more business oriented. Planners will conduct more validity studies using data from microcomputer based succession planning packages in order to relate the selection and development of succession candidates and high potentials to corporate performance. Activity analysis computer programs will evolve into expert systems that suggest better assignments of tasks to jobs, how productive people ought to be at various tasks, and what some logical career paths ought to be. Computerized animation and expert systems will make the technical aspects of flow modeling almost transparent to the user and allow a wider circle of managers to interact with models.

Introduction

During the 10 years that this journal has been published, there have been dramatic changes in how computers have been used in many areas of business. Many, if not most of these changes have had their parallel in the practice of human resource planning. The reason for this is simple. When planners and analysts have decided to computerize an existing planning tool or to implement it directly via a computer system, they have looked at the computer resources available to them and chosen those that would provide the greatest impact.

The choice of computer resources has, and continues to be, an organizational as well as a technical decision. The choice of which computer resources to use can affect (1) which other parts of the organization a planner will depend on for computer resources, (2) what kinds of data can be retrieved and converted into information useful for decision making, (3) the format and timeliness of information that can be made available to decision makers, and (4) how the information is accepted. In the final analysis, the choice of computer resources can effect the very role that the human resource planner will play in the corporation.

This article discusses some historical trends in the choices of computer resources by human resource planners and extrapolates these trends for the near future. While the innovations of the past may seem fairly commonplace to the new practitioner, a review is needed to demonstrate the logical continuity of future applications with those of the past and present.

The focus is on the effect that computers have had on the *state of the best practice* in corporate human resource planning in North America.[1] Best practice means that we will *not* be considering "state of the art"

[1] Extensive applications of computer based human resource planning techniques in the United Kingdom, especially in the area of flow modeling, have pre-dated many of those in North America. Descriptions of some of these early applications can be found in Smith (1976).

—the large number of potential applications of computers that have been described in the literature but which have never been selected for implementation by a meaningful number of practitioners. Also, we will not be reviewing what is *typical* practice. Over the years a number of surveys have been published in this journal documenting the small percentage of practitioners who use computer based planning techniques (English, 1984; Feuer, Niehaus, and Sheridan, 1984; Greer and Armstrong, 1980; Fiorito, Stone and Greer, 1985; Kahalas, *et al.*, 1980; Manzini, 1984). The reasons for the small percentage has been attributed to the lack of sufficient background skills by many planners (Strauss and Burack 1983), organizational factors, and poor implementation strategies (Lee 1986; Gillam and Hawkins 1987). Then too, it takes time to disseminate best practice.

In this article I will point out a number of "milestones" in the contribution of computers to the best practice of human resource planning. The focus will be exclusively on the corporate sector of the economy. This is where the overwhelming majority of members of the Human Resource Planning Society are employed.[2] Some of the milestones have been well documented in the literature; others have not. The literature typically focuses on the content of the human resource planning technique being discussed rather than on the computer resources used to facilitate the technique. For this reason I will sometimes rely on my own experiences and on information gathered from those human resource planners with whom I interact. Our look into the future will also incorporate predictions from a modified Delphi study of clients of the firm VRC Consulting Group (1985) and predictions made by Alfred J. Walker (1987) in an admittedly "speculative outline" of events until the year 2,000 "based on realities evident today." I apologize to the reader who may have set a milestone earlier than my accounting of it, and to the reader who has already implemented a milestone that I project for the future. I only hope that you will let me know about your work in case I am privileged again to look into my crystal ball. Let's look now at some ways that computers will affect the roles of human resource planners in four areas: accessing external data bases, succession planning, career pathing, and flow modeling.

Accessing External Data Bases

With the ever-increasing growth in the use of microcomputers in the U.S. business firms, certain uses of mainframe computers have declined. Other uses, however have increased dramatically. One of the most important growth areas has been the number of mainframe-based, public data bases that can be accessed world-wide by microcomputers connected to standard telephone lines via modems.

These data bases bring incredible speed to the process of doing business-related research. Manual library research is time consuming and sometimes fails to uncover all the information needed. On the other hand, a keyword search of an electronic data base can with lightning speed uncover "all" instances of the keyword in all the years of the literature stored in the data base. If keywords or combinations of keywords are chosen judiciously, useful information can be quickly separated out from what is not useful, and relevant articles and other information can be displayed on the user's computer or printer, or printed off-line for next day mailing.

[2] It should be noted that many improvements in the use of computers for public sector human resource planning have been made in the last 10 years. Knowledge of these advances has always moved in an orderly, if not rapid, way to the private sector through individuals leaving the military for civilian jobs, gatekeepers such as Niehaus (1979) whose material is widely available to the private sector, and the Society's Research Symposia which has had representation from both public and private sector researchers.

Walker (1987) sees increased linkages by HRIS systems with these "national and international information banks."[3] I certainly agree. Access to these data banks can increase the efficiency with which planners complete their administrative and research tasks, and can enable planners to play more visible roles in the formulation of corporate strategy.

Administrative Applications

Today's human resource department must keep abreast of a tremendous number of legal, regulatory and judicial developments. If a firm has offices in different states (and countries) and is considering instituting a new human resource policy, then it must consider if the new policy will conform to all the legal, regulatory and judicial constraints in each jurisdiction where it does business. One of the more practical ways of keeping up to date with the many developments that must be monitored is to subscribe to information services such as those provided by the Bureau of National Affairs. These services send periodic updates of developments in the form of inserts to loose leaf binders. Updated indexes to the material help with the research process. While these paper-based services represent a great improvement over visits to law and business libraries, to be used effectively a fair degree of administrative time must be spent in inserting new material, deleting old material, and scanning the material when a research question comes up.

To make its information more accessible, the Bureau of National Affairs through its subsidiary Executive Telecom Systems, Inc., has in recent years been maintaining the Human Resource Information Network (HRIN). According to Beer (1985), it is "one of the first national electronic networks dedicated to Human Resource Management." It contains current and historical information on "administration and tax, employment, labor/law, AAP/EEO, compensation and benefits, safety and health, labor relations, training and development, and executive information." The use of HRIN and future data bases like it has the potential to speed up the process of accessing relevant research data thereby saving the human resource department the administrative hassle of maintaining another set of documents.

Electronic versions of a number of human resource related publications are now available on public data bases (DGM Associates, 1986). Some data bases have established electronic bulletin boards to promote informal communications among human resource professionals. The *HR/PC* newsletter, for example, has established an electronic bulletin board on Lockheed's Dialog system to promote discussion among its readers (Mahl, 1986). The HRIN also promotes networking via electronic mail and bulletin boards devoted to a wide range of topics including Succession Planning (Beer, 1985). Finally, the *Survey* is an off-line data base sponsored by the Saratoga Institute. Subscribers receive a microcomputer diskette which contains the results of an on-going survey of trends of numerous measures of the effectiveness of the human resource department. Individual subscribers to this service can input measures of their own firm's human resource department's effectiveness and compare it to national norms (DGM Associates 1987, p. 78).

Strategic Applications

I personally have a vision that many human resource planners will be accessing public data bases and using them for strategic planning purposes. Most noteworthy of these, perhaps, is competitor data. Walker (1987) also foresees the collection, storage, and use of competitor data on HRIS systems.

[3] Walker also foresees computer data moving outwardly from the corporation in a limited and as necessary degree, to such entities as insurance carriers and governmental bodies.

A vital, early step to take in strategic planning is to analyze the strengths and weaknesses of one's own firm with respect to *specific* competitors in the same industry. Human resource planners should ask: "What kinds of people and skills will help attain or maintain the relative advantage of my firm over its chief competitor, the XYZ company?" Several human resource planners have even asserted that competitor analysis should be the starting point for all human resource planning (Mallia 1985; Gould 1984).

Data about competitors has always been available, but it has been accessible only by dogged and time consuming research with the inevitable result that most firms historically just have not done it, or have done it in a haphazard way (Porter 1980, pp. 47-48). In just the last few years, however, the massive growth of public data bases has revolutionized competitor intelligence gathering. Data can now be obtained quickly, and considering the benefits, for a reasonable cost (Fuld 1985).

There are two kinds of competitor intelligence that human resource planners can gather. The first kind can be used directly in the human resource plan. How do the firm's *human resources* stack up against actual and potential competitors? What kinds of skills and people give an advantage? What is the best way to obtain these people? Which competitors are attracting them? Which competitors have the most productive workforces? These kinds of data can now be obtained from data bases that contain information such as numbers of employees by company and work site, local and national newspaper articles featuring company specific data, financial data bases from which productivity ratios can be calculated, and electronic job-bank data bases where competitor recruiting strategies can be analyzed.

Both the VRC Consulting Group study (1985) and Walker (1987) predict that human resource data will become more and more available to other functions of the firm, such as finance, marketing and production, and that human resources departments will make greater use of data from those functions. Sophisticated networks will make this "cross-organizational data" transfer easy. One kind of data that I see moving along this network is competitor intelligence gathered by human resources, which will be of immediate use for strategic planning and marketing.

For example, Smith (1983) has shown that some very straightforward CEO biographical and developmental data is predictive of the long-term strategy that the CEO will pursue. When a new CEO is installed at a competing firm, who is better able to gather and interpret relevant data surrounding this event than human resources? Frazier (1985) has shown that the needed data items can be obtained rapidly from public data bases. If a competitor maintains a succession planning process, it can be monitored through job change notices in data bases containing local and national newspapers. Who is better positioned in the corporation, or who is better qualified by training and experience, than the human resource planner for assessing the strengths and weaknesses of competitor managements and what they imply in terms of the kinds of business moves the competitor can and cannot effectively make?

Succession Planning

Succession planning has been conducted by U.S. business firms at least as far back as 1944 when Standard Oil of New Jersey (now Exxon) began doing it (Mahler and Gains, 1983). Succession planning may involve identifying replacements for key jobs, creating an actual scenario of job moves over a five year period (forward planning), or identifying target jobs toward which individuals in talent pools are working. The best practice in succession planning also involves executive reviews where individual development plans are prepared for the upcoming year and the previous year's development is reviewed.

Associated with many succession plans are procedures for identifying and developing high potential managers. Most succession and high potential identification plans are considered business plans and are not widely distributed in the firm. Individuals named in these plans are often not even informed of their being listed.

Some aspects of succession planning are amenable to computerization. The information that is used in succession planning is typically in the form of individual development plans and/or "resumes" of the individuals being considered. Some of the data in these documents is in computer manipulatable form and some of it is in narrative form.

For about the first six years of this Society's existence I was privileged to be able to work in a number of roles with the Professional Development Committee of the Human Resource Planning Society and attend most of its workshops. During this period, when planners talked about succession planning they would often note that whatever data was used in the process, it had to be nearly flawless and up-to-date. Top executives who attended the executive reviews would not tolerate out-of-date information for the kind of decisions they were making. This resulted in a flurry of activity on the part of planners just before the reviews to ensure that records were current. It was a hectic process because executives were always changing jobs and participating in developmental activities and workshops and roundtables.

Some firms placed their resumes and development plans on word processing machines. This helped streamline the planner's work. A few companies kept the documents of mainframe computers, but most decided against this because of concerns about who might gain illegitimate access to the succession data. Since most firms kept their plans secret there was always a lot of interest in their contents by those not sitting in on executive reviews. Some companies even used external timesharing services for succession planning documents under the rationale that it limited the number of those *inside* the firm with access.

When microcomputers began to be available in business firms, a few alert planners quickly began to place their succession planning data on these. According to English (1983), succession planning and the microcomputer were made for each other. In the first place, the microcomputer solved many of the data storage and retrieval problems at a very reasonable cost.

Most succession processes involve a small number of employees so early microprocessors were capable of handling the data storage and retrieval requirements at most firms. Eventually microcomputer storage capacities increased and even the largest of the processes could be maintained.

Along with its ability to handle the needed data, the microcomputers enabled the results of succession planning to be kept private. The plans should be stored on one of just a few diskettes which could be easily stored in a locked cabinet when not in use. (A common story is that banks store the diskettes in vaults.)

At the heart of microcomputer succession planning systems is *data base management system (DBMS) software*, which enables individual records on file to be retrieved according to the contents of various "fields" or sections of the records. Not only can data be retrieved, but counts can be made of the number of occurrences of various types of entries in each section of the records being stored. This allows for the automatic preparation of all kinds of reports that formerly had to be done by hand (or not at all). For example, the computer could prepare a report describing the number of persons who were named to be replacements for more than one job, signaling that the firm's bench strength was not as great as it might seem at first glance. Age profiles could be built to see if top management might be subject

to mass retirements within a short period of time.

Not surprisingly, microcomputer succession planning programs were packaged and made available commercially. Interestingly, the first one on the market emphasized the display of replacement charts with color coded backup charts that many firms maintained in their "war rooms." What I believe was the second entry emphasized the reporting and retrieval of records and the preparation of reports.

There are now at least seven commercially available microcomputer based succession planning programs on the market (DGM Associates, 1987; Frantzreb, 1987). Some of these programs have been purchased by firms as a way of getting started with succession planning.

How has the computer affected the role of succession planners? For many, problems with data credibility have been nearly eliminated. For some, reports that evaluate how well the process is being conducted are being generated where resource restrictions prohibited them before. One of the biggest pitfalls in succession planning has been the preparation of elaborate development plans that are not followed-up. The calendars and tickler files in some succession software provide a psychological aid for overcoming this pitfall.

A common belief is that it takes a good five years to get the momentum up for a newly established succession planning process. There is reason to believe that microcomputers can reduce this time. Consider a feature of one package that can establish a baseline of initial backups for each job automatically. This is done by simply specifying the attributes desired for a backup. The software searches employee files for employees most closely meeting those attributes. Of course, the resulting list is just a starting point for further consideration of narrative material and inputs from members of the review committee who have worked with the named individuals. Nevertheless, the computer has given the committee a good start.

Microcomputers have certainly enabled human resource planners who facilitate succession planning processes to put some showmanship into the process. Most packages have the capability to instantly prepare backup, forward planning and other charts which can then be projected on a large wall screen for an entire review committee to see and discuss. "What if" scenarios can be devised and alternative plans displayed and evaluated in a timely manner.

What of the future? I can see some substantial advancements in the validity of the succession planning process stemming from the fact that a great deal of data is now being collected in a retrievable form for the first time.

Succession planning is without a doubt a largely subjective process. And it will always be so. Managerial work is difficult to characterize and evaluate. Even so, given the long history of succession planning, it is surprising that several recent surveys (Bolt 1982; Rhodes and Walker 1984) found few of the better known succession planning processes to use such techniques as assessment centers to judge the potential of their succession and high potential candidates. Even the increasingly popular notion of assigning corporate managers to jobs based on a match between their skills and business strategies has been criticized as being without any empirical validity (Kerr 1982). Managers sitting on executive review committees are oftentimes skeptical about the benefits of a process that has so few objective guidelines.

Statistical methods for establishing the predictive validity of the relationship between assessment center performance, biological data, and development programs to future performance have been available for decades. Microcomputer succession planning packages have convenient storage fields for all this predictive data including multiple dimension performance

and potential profiles. Hopefully this new availability of manipulatable data will encourage some useful validity research.

Because of the secrecy surrounding the process of succession planning, this kind of research will likely be firm specific. This will give a number of human resource planners the opportunity to affect the bottom line success of their firms through more effective selection and development of future leaders.

Career Pathing

A great deal of research was conducted by the U.S. Air Force in the 1960s and 1970s on new techniques for job analysis.[4] The technology involved periodic administration of questionnaires or "task inventories" to job incumbents and their supervisors. In the Air Force a rotating system was developed so that new task inventories were administered to each Air Force Specialty Code (AFSC) in the enlisted ranks on the average of every four years.

The inventories consisted of long lists of tasks that might be done on the job. Random samples of job incumbents checked off which activities they performed, how often they performed them, and their qualifications for doing each task. The Air Force did a great deal of research on the reliability of supervisor vs. subordinate responses, needed frequency of updates, number of respondents required, etc.

Individual responses to the inventories were loaded onto computers and analyses were conducted via a series of computer programs that went under the name of Comprehensive Occupational Data Analysis Programs (CODAP).[5] These programs were run in batch mode on mainframe computers. The CODAP program was fairly large, and even though it utilized a number of time and space saving techniques it used up a large proportion of the computer resources available on large mainframes of its time.

CODAP did a number of useful things for the Air Force. For example, it generated updated job descriptions. It also provided the Air Force Training Command with useful information about changes in the tasks people were actually performing on the job so future incumbents could be better prepared.

CODAP employed a statistical technique called "hierarchial grouping" to organize individual specialties into job families. Sometimes the jobs clustered together followed traditional job family definitions, but in other cases new and sometimes surprising relationships appeared.

My favorite example of a new relationship occurred at a time when there were excess personnel in the plumbing career field. The Air Force was always in need of Senior Non-Commissioned Officers in the enlisted ranks and was not anxious for excess personnel in the plumbing field to leave at the end of their first four or six year term. A CODAP analysis revealed that at the career point when many first enlistments were up there was a shortage of trained personnel in the *dental* career field and that many of the dentistry jobs were similar to those in the plumbing career field in terms of the time spent on certain tasks. This was a result that was unexpected by career management specialists.

A closer look at the task similarities revealed the rationale for the grouping. Although we do not notice it so much today, there is a lot of plumbing in a dentist's office. It has to be installed when new offices are opened up, maintained, and repaired as needed. Thus there were many activities that personnel from the plumbing career field could do in dental

[4] Most of the information in this section is from my memory of presentations I attended from 1971-75 while I was in the U.S. Air Force assigned to the Air Force Human Resources Laboratory in San Antonio, Texas.

[5] The most accessible description of CODAP can be found in chapter 8 of Niehaus (1979).

offices. Obviously, there were new tasks to be learned, but the former plumbers could perform useful tasks while they were learning the new ones.

The CODAP research, computer programs, and limited consultation were provided by the Air Force to other U.S. military services, some military services in friendly nations, and other public sector organizations. For a modest fee the documentation and computer program were made available to the private sector via the National Technical Information Service (NTIS).

When used in the private sector, the technology pioneered by the Air Force became commonly known as activity analysis. One way in which this technology first worked its way into the private sector is quite neatly demonstrated by what the consulting firm TPF&C has done with it in recent years (Bechet, 1987).

In 1980, TPF&C did some work with the State of Florida to reduce the number of different job classifications involved in describing the jobs of state employees. TPF&C used activity analysis techniques to reduce the number of jobs from 3600 down to a more manageable 1200. To accomplish this it used a version of the CODAP program that had been installed at the Florida State University. More recently, the firm has developed its own activity analysis program, "Staffing Plus." It has the advantage of being interactive and it runs on a microcomputer. As with CODAP, it employs task inventories completed by job incumbents. The program has three functions: (1) to describe the current productivity and utilization of the workforce, (2) to perform clustering routines so that the organization can be analyzed in a number of ways, and (3) to enable a cost analysis of activities being done by a firm. As with CODAP, some of these functions are useful for organizational analyses in the short term, while others can be used for longer-range planning functions such as career pathing (Bechet, 1987).

According to Bechet (1987), a useful and quite feasible extension of Staffing Plus would be an expert system to suggest the tasks that people *should* be doing, perhaps what they *should* be paid for doing it, how productive they *ought* to be at various tasks, and what some logical career paths *ought* to be. Expert systems are an application of the discipline of artificial intelligence. Walker (1987) forsees greater uses of expert systems by the human resource department in the near future. Indeed, computer software that facilitates building expert systems is now commercially available on microcomputers and mainframes at all ranges of the cost spectrum (Harmon, 1987).

There are at least four commercially available activity analysis microcomputer packages now on the market (DGM Associates, 1987; Frantzreb, 1987). The construction of an expert system for activity analysis awaits a planner who has cross-organizational experience with activity analysis and the time available to do it. The need for such a system in these days of "lean and mean" organizations is quite apparent.

Flow Models

For about the last 20 years or so, firms in this country have been developing and using human resource flow models. These models require that a firm categorize its employee population according to some scheme, measure the historical rates of movement or flow of employees between the categories, and then use these rates to project future movements.

Some models categorize employees according to the number of years they have been with the firm. Projections are then made for future years of the number of people who will likely leave, and of the number who will stay and gain another year's experience. Some models describe the flow of people through levels of the corporate hierarchy and/or job families. Other models simulate employee aging.

The projected flows from the models are

then used to diagnose current human resource policy and practices. Questions that can be addressed are: what will happen if current trends continue in human resource policy and practice? and, What will happen if the current policy and practice are altered? As Milkovich and Phillips (1986) state, flow models "help identify or verify organizational problems with enough lead-time to permit taking non-drastic corrective action, e.g. mass layoffs, etc."

Examples of companies who have benefited greatly from the use of flow models include: Union Oil Co., which attained significant savings in recruiting costs by smoothing out cyclical recruiting patterns (Bright 1976); Weyerhaeuser Corp., which calculated that in order to meet capital growth targets it would have to implement replacement planning and stepped up management development and recruitment (Buller and Maki, 1981); Seattle First National Bank, which was able to keep on target with its EEO goals by accurately forecasting promotions, transfers, attrition and needed recruitment of women and minorities (Gillam and Hawkins, 1987); and the Aluminum Company of Canada, which was able to pinpoint and correct a costly turnover problem (Pinfield *et al*, 1979; Pinfield, 1981).

The process of building a model usually involves creating two or more types of computer software. A first type, if used at all, generates the needed numbers of people in each category for the next 1,2...5 or more years.[6] A second type of software generates a data base of historical rates of flow from individual personnel records. Historical flows for attrition, promotion, transfer, recruitment, and other moves are determined from a large (usually 100%) sample of employee moves over a (usually) 1-5 year period. This is most often done by taking computerized personnel rosters from various years, matching up individuals to see what moves they have made from year to year, and then converting the number of movements to rates of movement. A third type of software involved in flow modeling applies these rates of movement to the current population of employees to make projections of future movements.

The earliest flow models were all run in a "batch" mode on mainframe computers. That is, an analyst with computer programming skills would submit directions to the computer which would, after some period of time, produce paper reports of predicted people flows. This process has changed a great deal in the last twenty years.

Interactive Models

As the hardware and software became available to them, model builders soon learned the benefits of programming models that run "interactively". In this mode of operation, a computer responds so quickly that users have the impression they are the only person being served even though there may be many others being attended to. (Today's microcomputers are perhaps the ultimate in interactive systems in that they are dedicated to a single user).

A flow model that is interactive permits a model builder to see immediately what the consequences of a particular set of personnel policies and assumptions are. "What if" scenarios can be tested out immediately. If a set of policies does not effectively deal with a particular set of environmental conditions, then another set of policies can be tried out. The results of one run suggest revised inputs for a second run and so on with (hopefully) an eventual convergence to several desired scenarios. This cycle of model building and re-building often leads to greater understanding of

[6] In many of the flow models discussed in this paper, the needs were determined not by a computer model, but by managerial judgements as part of a strategic planning process and used directly by the flow model.

the personnel system and flows of people through corporate hierarchies.

It is possible, of course, to enumerate a large number of combinations of policies, run them all at once and then review the results. However, this is very time consuming and actually takes longer to converge on a final set of human resource policies than directly interacting with a flow model.

I believe that the prime motivating factor in the choice of computer hardware and software by human resource flow model builders for the last 15 years has been to *expand the number of people who would be able to experience this interaction with a model.* Most flow models historically have been programmed by management scientists, operations research analysts, mathematicians, statisticians, and data processing specialists. The most successful of these model builders have usually (though not always) attempted to widen the circle of model users to human resource planners. (On occasion, a human resource planner has described a model conceptually and had an analyst program it.)

Many times the circle of users was then expanded to other human resource professionals, such as recruiting managers, EEO specialists, and career counselors at both corporate and divisional levels. Another goal has been to expand the circle of users to include the line managers who make final decisions about employment and recruitment levels. This final circle has certainly been reached indirectly when human resource managers have acted as consultants to the line.

Several generic strategies were used early on to expand the circle of users. One strategy was to have the model builder participate directly in line management meetings. This strategy proved effective at Weyerhaeuser, for example, where "representatives from Manpower Planning met quarterly with a senior management committee to review [corporate] capital plans and their human resource implications" (Buller and Maki, 1981, p. 133).

Another strategy to widen the circle of users was to specifically program flow models to make them accessible to persons with little or no data processing skills. The most common way to do this was via "menus" that supplied the user with a number of options for model assumptions and data items, and queried the user for his/her choice. Sometimes the menus filled the screen with detailed instructions and thus greatly simplified the manner in which the model could be used.

At Seattle First National Bank, for example, the Operations Research Staff re-programmed its flow model to be menu-driven so that the staff of the Manpower Planning section could be trained to run the model in less than an hour (Gillam and Hawkins, 1987). The Manpower Planning section staff was then able to consult with the various units of the bank to assist them in creating staffing and EEO plans. At Sears, a model was built by a human resource planner with assistance from contract programming personnel. The menu-driven model was designed for and used by regional recruiting managers (Miller, 1980).

Menu driven systems were not acceptable to all flow model builders, however. The experience of many users of menu-driven computer systems in other areas of business was that while they appreciated being "walked through" a given program the first few times they used it, they soon became impatient with menus that used up a lot of time and filled the screen with information the user had already learned. Some users expressed the desire to enter all input at one time, instead of having to plough through several screens of information. These users felt menus took too long to be displayed on the computer terminal and inhibited experimentation with the model.

Because of the problems with menus, programmers began developing computer programs that could understand simple English language commands. Individuals

without extensive programming abilities could then enter a set of English style commands and other information on a single line, which might be the equivalent to the responses entered during several computer screens of menus. To save on unnecessary typing, commands would often have recognizable abbreviations. One command that all such programs had in common was "HELP" which enabled the new user to learn about the program and the experienced user to refresh his/her memory about it.

Model Building Languages

A key milestone in the best practice of human resource flow modeling were the development of AT&T's Interactive Flow Simulator (IFS) in the mid 1970s (see Boza, 1978). IFS was based on years of experience with flow modeling in the Bell System. Its development cost has been estimated at over $3 million (Gainsborg, 1982). IFS employed many state of the art programming techniques available at the time of its development and included a few innovations of its own.

IFS was not just a model, it was a workbench for modeling, or to use a term I prefer, a *model building language.* It did not restrict the kinds of models users could use to simulate the flow of people through a hierarchy. A user could simulate the aging of the workforce, simulate the flow of employees throughout various job levels, or even simulate the flow of employees through complex job families. The user could also select the forces guiding the movements of people through a hierarchy. IFS could replace the models used at Weyerhaeuser, Seafirst, Union Oil and Merek & Co., which were classical "supply-push" Markov models wherein the flows between categories were projected as fixed (usually historically-based) percentages of people in that category. IFS could also replicate the models at Bank of America (Frantzreb, 1979) and Sears, which were primarily "demand-pull" models in that promotion flows out of a job were determined by vacancies in the next grade up in the hierarchy.

IFS was available to all Bell System companies on their mainframes. It enabled AT&T to require all of its units to have access to state of the art modeling tools and to submit tailor-made human resource plans within a uniform format. IFS had some disadvantages, however. It was relatively expensive to run. The early syntax was not as friendly as it could have been. (This was later improved, I understand.) It had large computer memory requirements and the mainframe computers it ran on were subject to slowness at busy times of the month. Also, the IFS system was, and is, an AT&T/Bell Operating Companies proprietary program.

Problems With Mainframes

When flow models were first being built by business firms in this country, computerized personnel data were usually resident on mainframe computers controlled by Data Processing (DP) departments. Human resources had very little priority over the use of DP's programming and other resources. Indeed, on of my first consulting jobs was to install a flow model purchased by a large firm. I was told by my client that the time and effort it took him to get approval to purchase the program was negligible compared to the time it took to get DP's approval to access the corporate personnel files and to free up a programmer to assist in the installation.

One way that some human resource departments circumvented such problems was to go outside the corporation for needed computer resources. By purchasing time on a commercial timesharing system, firms could input their human resource data into the system's mainframe computers using terminals, modems, and phone lines at company headquarters and subsidiary offices. I found the installation and use of flow models in this environment to be somewhat easier than when the HRIS was in-house. These timesharing systems, however, were generally a fairly

expensive way to maintain personnel data and many companies eventually moved their human resource information systems in-house.

There have been a number of changes in recent years in how DP resources are allocated to human resources. In some firms the status of the human resource department has improved giving it a higher priority for computer resources. Some human resource departments now have their own programming staff and human resource information centers to permit better access by human resources to its own data. A whole new professional society, The Association of Human Resource Professionals, Inc. (HRSP), which includes persons who build and maintain these centers, has grown up in the last 10 years. Also, minicomputer and microcomputer systems have been designed and marketed with the sole purpose of storing and processing human resource data.

Microcomputer Flow Models

Because of the frequent problems associated with using mainframe computers, as soon as microcomputers began to appear, human resource planners began writing flow models for them. I was unimpressed with the earliest of these models because of their slowness. It could take five or more minutes to generate a five year projection for a model with just 50 categories of employees. This lack of speed discouraged the interactive cycle of model building, model interpretation and model rebuilding that worked so well on mainframe systems.

Soon, microcomputers increased in speed and projection times improved. A number of microcomputer flow models became available commercially. While none of the commercial microcomputer systems were model building languages and very few included the capability of calculating flow rates required by the models, they were certainly inexpensive ways for a firm to get started with flow modeling (see DGM Associates, 1987; Frantzreb 1987).

As the growth in sales of microcomputers continued, many new innovations in computing occurred on these machines rather than on mainframe machines.[7] One example of this is a new way of giving instructions to computers, most commonly referred to as "Lotus style menus" (after the menus used in LOTUS 123 spreadsheets). These menus are a microcomputer innovation that, in my opinion, are a much better way to drive a flow model than either the menus or English-language commands discussed earlier. With these new menus, all options can be displayed quickly, any option can be chosen by a single keystroke (or by using a mouse), and an entire sequence of commands can be entered at one time without waiting for the computer to respond.

Spreadsheets themselves can be used as vehicles for model building languages. The advantages of spreadsheets for flow model building were certainly apparent to human resource planners at Lockheed Missiles and Space Company (Quigley and Henshaw, 1987). That company developed a model for allocating merit pay driven by age and length of service attrition flows. The initial calculations of flow rates were performed on a mainframe and then entered into a LOTUS 123 spreadsheet on an IBM/PC where the model was developed. A microcomputer spreadsheet was intentionally chosen for model development in order "to reduce costs, to enhance profitability, to [make sure the model was] easy to use, and to gain the flexibility needed to manipulate input variables in

[7] In order to better illustrate my points, I have somewhat overstated the differences between microcomputers and mainframes. Some new technology does indeed get implemented first on mainframes, and other technology eventually migrates from microcomputers to mainframes. The distinction between mainframes and microcomputers also becomes somewhat blurred when local area networks are used to link several microcomputers together. See Anderson (1985) for a more complete discussion of these notions as they apply to HRIS systems.

the model" (p. 187).

The computer resource choices made recently by Bell South for its model building language summarize some of the advantages of microcomputers for flow modeling (Howell 1987). A number of computer resources were available to the firm. The corporate mainframe could have been used to access the IFS system or to program an entirely new model. However, a microcomputer environment was chosen over mainframe options because it allowed for a higher standard of service to managers needing flow model projections.

While some projections are needed on a regular, periodic basis, others are requested adhoc. To meet these latter one-time requests, a number of reports are produced to *inventory* in anticipation that requests will be made for some of the information contained therein! The service standard is that 90 percent of ad-hoc inquiries should be answered from the inventory, and another 9 percent in less than 48 hours. When the choice of computer resources for the flow model was being made, it was felt that because the corporate mainframe could get very busy (especially at the end of the month), there was a large risk that a flow model programmed on it would not meet the desired service standard.

For flow modeling, one advantage of the microcomputer environment over that of the mainframe was operating costs. Another advantage was that it would enable a more rapid tie-in to presentation graphics and desktop publishing. The Bell South model was programmed in a popular advanced BASIC language to emulate the most practical features of the IFS system. Spreadsheet style menus guide the user through model runs.

At the time this article was being written, the microcomputer system was not able to make flow projections as fast as a mainframe could. A six-year projection of a workforce divided into 100 categories would take about 40 seconds to complete. Although this kind of projection can be done nearly instantaneously on a mainframe, the time differences are not believed to be a significant handicap.

Generating the Flow Model Data Base

One part of the flow models that are invisible to most users is the software that reads individual personnel records and calculates historical rates of flow. When this journal began publication, most if not all *large* firms in the U.S. had their personnel records computerized on mainframe HRIS systems. In the time period since, both mainframe and microcomputer based HRIS have become commonplace even in small firms.

The early HRIS systems at most firms were not capable of doing sophisticated matchings of personnel rosters from year to year so that rates of movement could easily be calculated. For example, at Weyerhaeuser, determining the rates of flow initially involved a process of manually cutting strips of papers from computer generated personnel rosters and taping them so that individuals would match up from year to year (Maki 1987). At Seattle First National Bank, employee rosters were printed out from payroll tapes and annotated by hand according to the job category an employee was in. The annotated printouts were then punched onto cards for entry into a data base where flow rates were then calculated. Other early data base problems have been documented by Frantzreb (1979).

To me, the Bell South model represents a milestone in best-practice flow modeling because it is the first microcomputer system that I am aware of that has been able to calculate flow rates on a large scale. Each quarter some 51 characters of data for each employee are downloaded via modem from the mainframe onto two hard disks on the microcomputer. This requires about 5-7 hours, but can be done over a weekend (Howell, 1987).

Using various data compression techniques the downloaded data are combined with previously stored information. Next,

files are built that describe (1) the current population, (2) the personnel movements since the previous download, and (3) the overall rates of movement. With this configuration, the model can easily handle a workforce of up to 100,000 employees. With advances in microcomputer technology on the immediate horizon, up to a million people could be processed. However a balance must be maintained between a natural desire to capture all data available on employees and the storage limits of the microcomputer. Decisions must be made ahead of time about which data items will most likely be needed to answer critical strategic questions of interest to users. The key becomes focusing on those strategic force planning questions that should and will be asked in the future (Howell, 1987).

Future Developments

I think we can make some reasonable predictions about what will be the best practice of flow modeling in the near future. In general, we can expect to see a larger number of firms building flow models. Flow models are a type of decision support tool. Both the VRC Consulting Group (1985) and Walker (1987) envision more decision support systems being used by human resource departments in the future. In order to be more specific about the future applications of flow models we should recall that the prime motivation of successful model builders has been to select computer resources that bring the experience of interacting with a model to a wider and wider circle of managers.

One feature I expect to see is greater ease in the choice of individual employee attributes that form the basis for the categorization scheme of a flow model. One way to make the process easier would be to use the newest generation of *data base management programs*. Geis and Flemholtz (1986) have shown how to use the most popular microcomputer data base management program to sort through individual personnel records, categorize employees, determine flows, and calculate flow rates. While using a DBMS to calculate flow rates is less efficient than a specialized program written for that purpose, computational efficiency is rapidly becoming less and less important than user convenience. Some software vendors are now working on voice activated data base management software, and so the process of generating rates could be made very simple to users.

Another logical advance in flow modeling would be better displays of the results. Presently we have quite sophisticated capabilities for translating table based projection data into bar, line and pie charts. But these are all highly summarized results. In order for a user to get an intuitive *feel* for the complex web of flows of people into, through, and out of hierarchies, the user must do a lot of experimentation. Even for the experienced analyst, making sense of the flows that commonly occur through a hierarchy of say 40 job categories over a five year horizon can be quite a task.

A real aid to the process would be computer generated animation. Consider, for example, the software packages commercially available that permit simulation of the flow of work-in-process through a factory. The user simply positions "icons" or pictures of various machines on the screen. The routing of work-in-process between the machines and priority of work to be processed on the machines is described by colored lines between icons.

Consider what such a system for human resource flow models would enable planners to do. Their models could be displayed on wall size screens at a meeting of line managers. Using icons to describe various hierarchical levels, job families, or other categorization schemes the framework of a model could be built. In just a moment's time historical rates of flow using that categorization scheme would be calculated and displayed in terms of colored lines between the icons. Wider lines or darker colors would represent larger rates of flow. Projections of future movements could be made in a dynamic

fashion like a movie.

By using color, the less significant moves could quickly be removed from the screen to focus on the major flows. Brief experiments could be conducted and relevant human resource decisions made with a good idea for their likely impact. None of this is fantasy. The technology is now available.

Another technology which could currently be applied to flow modeling is the use of expert systems. Based on my own experience in dealing with a number of clients, cases reported in the literature, and in my discussion with other planners, I have found a number of common recurring patterns in the flows of people through vastly different kinds of hierarchies. Clients are often surprised to see these patterns since they often believe their firm to be unique.

Some of these typical patterns include the ever present U shape of attrition and retirement rates as a function of length of service and age; the high degree of forecasting accuracy that can be obtained when length of service or age are used in a model's category definitions; and a tendency toward top-heaviness in hierarchies when a period of employment growth comes to an end. Knowledge like this from experienced model builders could be incorporated in an expert system to make it easier for a wider circle of managers to interact with flow models.

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